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PIPE LINE INDUSTRY

NOVEMBER
1960

Control—Communications Special Report

AUTOMATIC LPG LINE

How New Mid-America Line Will Work 36

99.973% RELIABILITY

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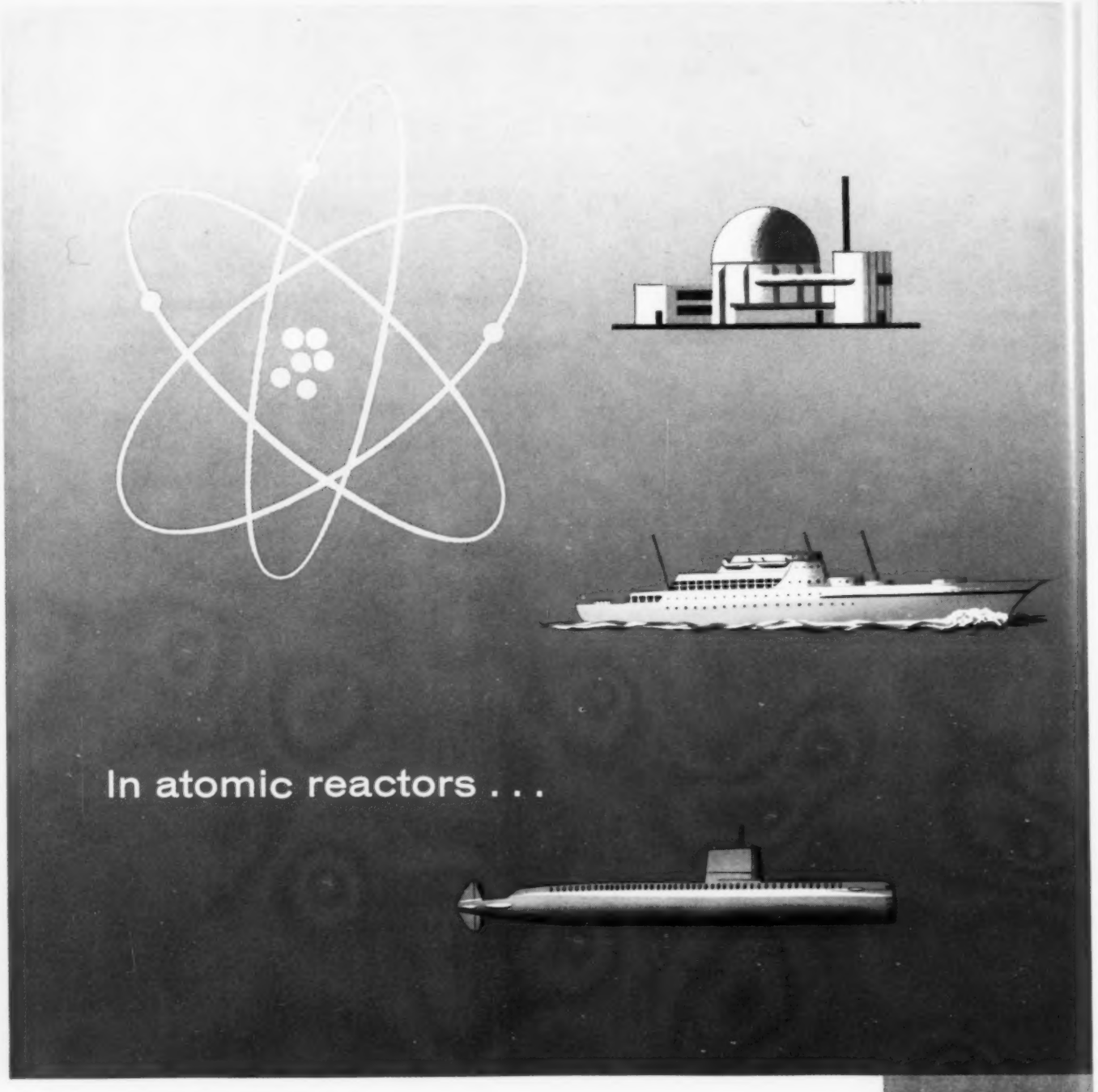

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PIPE LINE INDUSTRY

A GULF PUBLISHING COMPANY PUBLICATION

November 1960 Vol. 13, No. 5

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To help you put first things first, scan these time-saving digests, checking ✓ those you want to read first.

CONTROL – COMMUNICATIONS SPECIAL REPORT

How Mid-America's LPG Line Will Be Operated

☐ Mid-America's 2,170-mile LPG system with 13 pump stations and nine terminals will soon be remotely controlled from Tulsa. The dispatcher can control product movement to any delivery point; he can open and close all valves needed to handle a delivery or movement of LPG to aboveground or cavern storage. New design features include reversed "latched-open" check valves placed in delivery lines to prevent overfilling or bleeding down line should power fail; new capacitance "probes" installed on upstream scraper traps to detect batch interface.

By Melvin A. Judah ..... Page 36

Dual-Beam Microwave System Averages Less Than 2½-Hours Outage Per Year

☐ This two-in-one system maintains separate horizontal and vertical radio frequency microwave paths. The reliability over the past four years has been 99.973 percent!

By G. V. Morck ..... Page 42

A Thin-Route Beyond-the-Horizon VHF System in the Middle East

☐ Links on this unique system range up to 120 miles for the 250 watt transmitters. The 160 mc point-to-point systems carry four-voice channels (three are derived and one is physical) and three-tone channels. On the large antenna arrays are two 250 watt transmitters and two receivers as well as a 250 watt transmitter for the mobile system and mobile relay system receivers. The system is made up of relatively simple low-cost 160 mc radio equipment—mostly of standard make.

By J. D. Hoffman ..... Page 44

Local Automation at Transwestern's Unattended Stations

☐ Most of the controls center around starting and stopping engines—avoiding mishaps which could interfere with either of these processes. Here is the step-by-step analysis and explanation of these sequences.

By R. W. Smith and J. G. Vletas ..... Page 51

Computer Program for a Heated Crude Line

☐ Calculating behavior of a heated crude oil line is so complex that it is an almost impractical problem for ordinary engineering computations. However, a computer can produce excellent results for determining throughputs and design data. Here is the way one company set up this problem for a computer.

By Dennis R. Horner and Paul Fried ..... Page 57

Computer Comes Up With Answers on Pipe Line Operations

☐ Tapline set up model of its pipe line and terminal in computers to find out in advance what will happen if its marine terminal is tied up by storms or its gas turbines fail. The answers have not only improved maintenance, they have pointed the way to possible future system improvements.

By Donald W. Dreier and Brice A. Sachs ..... Page 62

Wire Mold on the Back of Communications Rack Simplifies Installation and Maintenance

☐ El Paso Natural contributes this money-saving idea to this issue ..... Page 66

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PIPE LINE INDUSTRY published every month. Second Class postage paid at Houston, Texas © Gulf Publishing Co., 1960.

Needed: Freedom from Federal Control

Although it has taken far too long—more than six years to be exact—the Federal Power Commission finally has made some strong admissions:

- The cost rate base method has been, is, and will be completely unworkable. The current rate case backlog, plus new cases to come, would take more than 80 years to settle—even if the FPC staff were tripled immediately.

- The cost rate base method is completely inequitable. It benefits the inefficient and unfortunate at the expense of the efficient and fortunate.

- The cost rate base method produces ridiculous results. Up to 50 people own a single well in some unitized fields. When cost is the basis for establishing rates, each owner is required to show his costs. This means virtually every thousand feet of natural gas produced from every single U.S. gas well may have a different price tag, ranging from 1 cent to $10 per Mcf.

Now, will the new area pricing policy be any better? The FPC believes it will:

- Sharply reduce the backlog of rate cases.
- Be more equitable for all concerned.
- Help to stabilize prices.

Even if this is true, the new policy leaves much to be desired. Producers still are regulated. They still are considered utilities, quasi or otherwise. They still cannot establish prices on a competitive basis. Costs still will be involved in establishing prices in some instances. Price increases may eventually be harder to come by.

The area pricing is far from being an established policy. In fact, the FPC expects its producer rate regulation plan to be contested in the courts on the ground that it is not lawful under a 1956 ruling by a U.S. Court of Appeals in the City of Detroit case. In that case, the FPC permitted Panhandle Eastern Pipe Line Company to use a commodity value in pricing gas which it produced itself. The court, however, remanded the case, stating that the higher rates represented an increase above that which would result from the conventional rate base method, which must be used "at least as a point of departure."

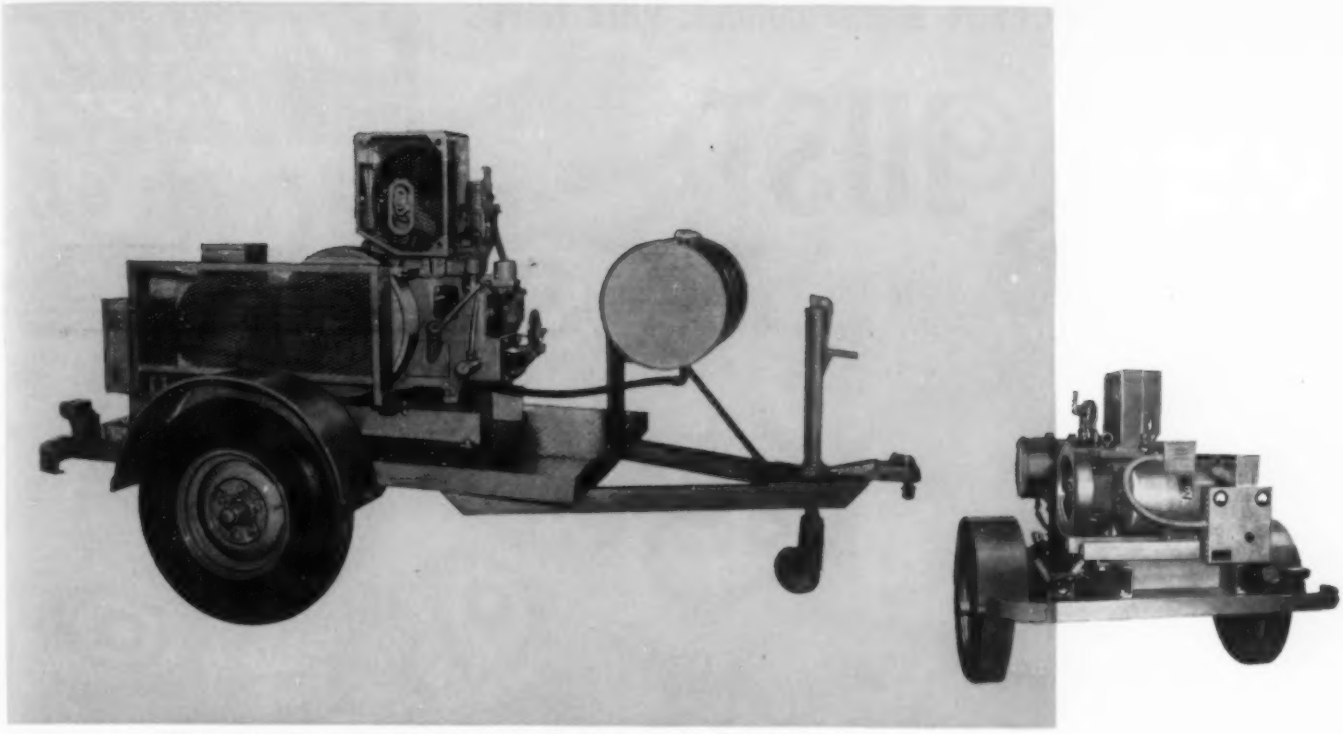
"If this contention is correct," the Commission declares, "Then, as a practical matter, adequate regulation of producers appears to be impossible under existing law."

Thus, there still remains only one solution to the longstanding, unfair, and uneconomic price control problem: Accept one fact—natural gas producers are *not* public utilities and do not belong under federal control—and pass legislation that will acknowledge and support this fact. This brings up the biggest question of all: Will area pricing stop or slow the expensive progress that has been made toward passing remedial legislation?

There are two schools of thought on this: One is that the tendency in Washington will be to give the new policy a try, thus further delaying a new natural gas bill. The other is that the new policy also will prove unworkable, will not be approved by the courts, throwing the entire confused situation back to the old cost rate base method. But even this will take time.

In the meantime, it might be well for natural gas producers not to put up too loud a squawk, go along with the new policy (considering it the lesser of the current two evils), and show as rapidly as possible that it, too, is completely unworkable.

Such cooperative action may in the long run aid in the achievement of remedial legislation. But, let us all hope this doesn't mean another six years.



Witte's 98RBD trailer-mounted engine-generator unit has a standard 3 KW DC shunt-wound generator in a wide speed range from 750 to 1800 rpm.

Witte 98RBD Cathodic Protection Unit enables you to offer pipeline customers another profitable service!

Here is a heavy-duty, highly mobile, cathodic protection unit that will enable a pipeline contractor to provide an added service to his customers. This engine-generator unit will afford him an opportunity of recommending and furnishing the necessary amount of protection when the pipeline is installed.

It is a known fact that a corroded pipeline cannot be restored, but corrosion loss can be stopped if cathodic protection steps are taken in the early stages of a pipeline installation.

Witte's 98RBD is built especially for this type of continuous operation. The heavy-duty oilfield-type gas engine has been thoroughly field-tested. It has a low center of gravity, is well-balanced, and every part is easily accessible. The engine has condenser cooling, removable wet cylinder liners, and roller main bearings. It is equipped for long-run service, having oil make-up reservoir and float valve as well as lube oil and cooling water safety controls.

These trailer-mounted units have a 32-40 volt, 3 KW generator in a wide speed range from 750 to 1800 rpm. They are V-belt driven, with a voltage control to less than 5 volts when the generator speed is 750 rpm.

Complete information on both the standard and trailer-mounted Witte gas engine-driven generator units is available through oilfield supply stores.

USS and Witte are registered trademarks

USS

Witte Engine Works
Oil Well Supply
Division of
United States Steel

Offices and Plants: Kansas City 26, Missouri

Why DARLING-McEVOY 2-way conduit gate valves

JUST CAN'T LEAK!

Section view of Darling-McEvoy 2-way conduit gate valve, showing twin sealant reservoirs, double-gate parallel seat design, and sealing grooves. Sizes: 8 inch and larger.

IT'S simple. Regardless of flow direction, a sealant *automatically* completes a pressure-tight seal between the downstream seat and gate. This is the inevitable result of pressure differential at the time of closure.

Similarly there can be no behind-the-seat leakage! For, as shown here, each seat is *double-grooved* to seal against the valve body as well as the gate.

It is this unique feature, with its positive, automatic self-sealing, that establishes the Darling-McEvoy conduit gate valve as the world's tightest!

Isn't it likely that you could benefit by such valve performance as time goes on? Get the *whole* story . . . get details on this and the other unusual features that make these field-proved valves truly outstanding for low-cost, trouble-free operation. Just ask for Bulletin 5402.

DARLING VALVES

DARLING VALVE & MANUFACTURING CO.

Williamsport 27, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ont.

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Published by

GULF PUBLISHING COMPANY

EXECUTIVE OFFICES: 3301 BUFFALO DRIVE, HOUSTON

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SUBSCRIPTIONS

R. B. Reilly, Circulation Manager, P O Box 2608, Houston 1, Texas, U.S.A. Single copies 50 cents. Double price for single copies more than a year old. Subscription rates: both foreign and domestic $2 a year, $3 for 2 years, $4 for 3 years. Copyright 1960 by Gulf Publishing Company.

Postmaster: Send notification (Form 3579) regarding undeliverable magazines to PIPE LINE INDUSTRY, Box 2608, Houston 1, Texas.

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PIPE LINE INDUSTRY and The PIPE LINE CATALOG for the oil and gas pipe line industry.

WORLD OIL (formerly the Oil Weekly) and The COMPOSITE CATALOG for the drilling-producing industry.

PETROLEUM REFINER and The REFINERY CATALOG for the Hydrocarbon Processing Industry.

Indexed by Engineering Index

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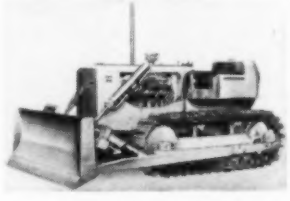
WHY GEORGE PEASE USES

D6s for SITE PREPARATION

THIS is one of 60 sites recently prepared by George W. Pease for a large oil company. The location: Osage County, Oklahoma. The job at each site: leveling an area about 85 feet x 130 feet for drilling rig and equipment and digging a slush pit 70 feet square and 5 feet deep. Depending on conditions, it took the Cat D6 Tractor with No. 6S Bulldozer from one to three days to prepare a site.

Why did George Pease choose the D6? An important reason, he'll tell you—"It stands up better than competitive machines." His is no snap judgment, for he's a veteran with 16 years' experience in the business. Ask others like him, who make their living in the same kind of tough work, and you'll hear the same verdict on the D6.



NOW THE NEW D6 SERIES B

Stacked against the previous model—or against any tractor of comparable size—the new D6B is even further out front from every angle: greater production, low-cost operation and time-saving maintenance. Some reasons why:

NEW ENGINE—A Cat D333 Diesel Engine (93 flywheel HP) delivers 25% more lugging ability. New direct-acting governor for quick fuel adjustments handles loads faster.

NEW INTEGRAL HYDRAULIC SYSTEM—Under-the-hood mounting of tank, pump and valves permits convenient routing of hydraulic lines to bulldozer or implement cylinders, frees front and rear for other equipment.

NEW OPERATOR CONVENIENCE—An all-new cockpit has coordinated controls that make the tractor operate almost as if it knew what was needed next.

NEW 8-FOOT BULLDOZER BLADE—This shorter straight blade combines productive capacity with narrow width. No highway permit is required to move machine from job to job.

And that's not all. The new D6B also features dry-type air cleaner, hydraulic track adjusters (optional), lifetime lubricated track rollers, the oil clutch and forward-reverse lever. Get the full details from your Caterpillar Dealer. Ask him to *show* you how the new D6 can step up production on your job!

Caterpillar Tractor Co., General Offices, Peoria, Illinois, U.S.A.

CATERPILLAR

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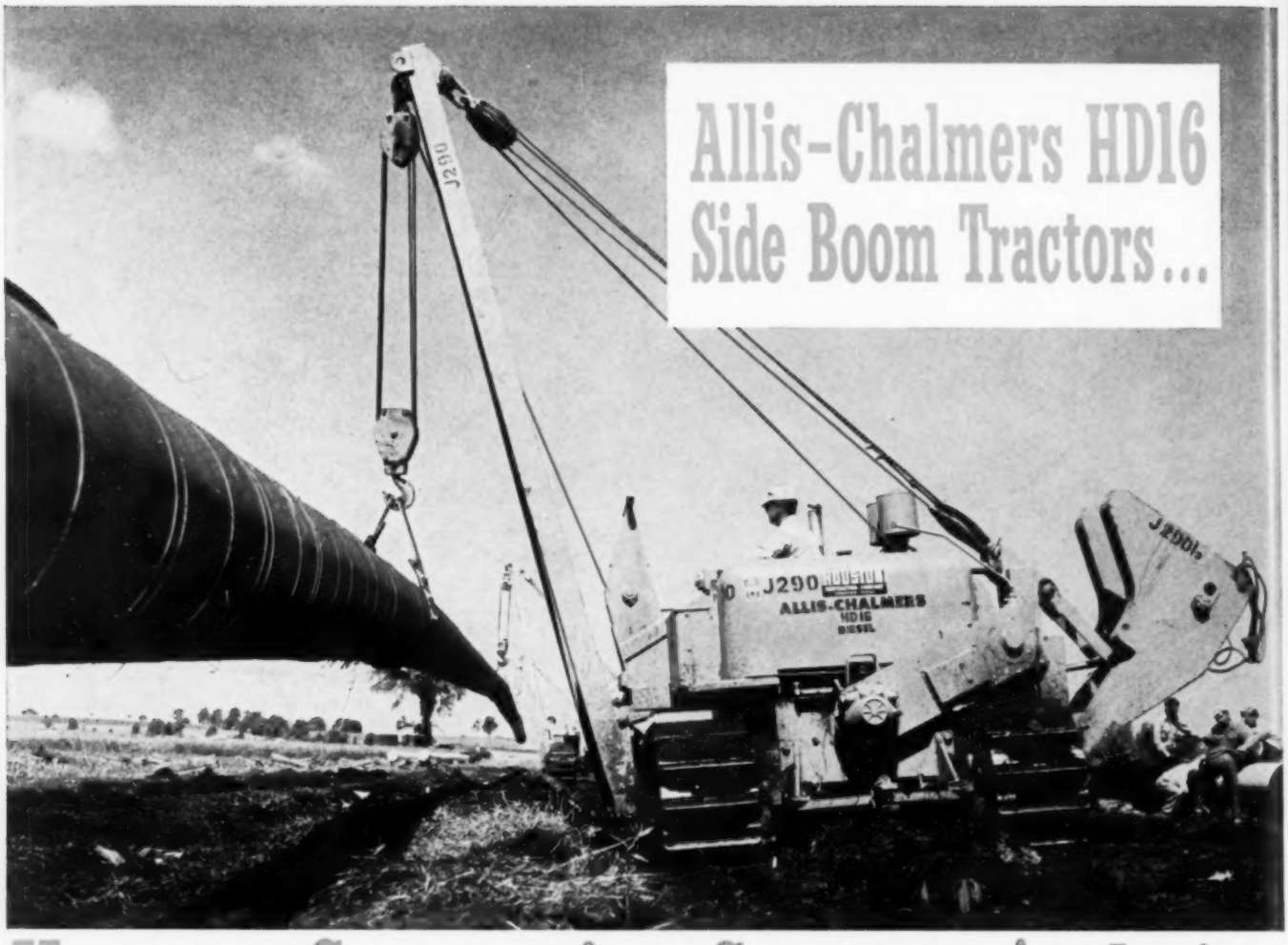
MODERN HEAVY-DUTY MACHINES FOR THE HARD WORK



Houston Contracting Company's choice for 24" Michigan-Wisconsin Pipe Line

There's a good reason for one of the leading pipeline construction company's selecting Allis-Chalmers for their job. First of all, the powerful high-clearance HD-16 is the best balanced tractor on the market which means more efficient operation in hilly and boggy terrain. The famous Allis-Chalmers torque converter is standard equipment in the HD-16 FC Boom Tractor and this means easy operation. And when you're laying pipe in hilly and mountainous terrain the Allis-Chalmers HD-16 has plenty of power—not only to pick up a load but to carry it as well. Still another feature of the HD-16 is the Decelerator foot throttle which frees the operator's hands so he can handle the side boom. The HD-16 costs surprisingly little to operate. Its 150 net hp engine can save you up to 27% in fuel over other tractors of comparable size. Permanently lubricated rollers, heavy duty, extra tough tracks keep maintenance costs low on the HD-16.

Call Brown-Fogle and ask to have a demonstration of the HD-16 soon.

BROWN-FOGLE EQUIPMENT CO.

8821 ALMEDA ROAD • P. O. BOX 14207

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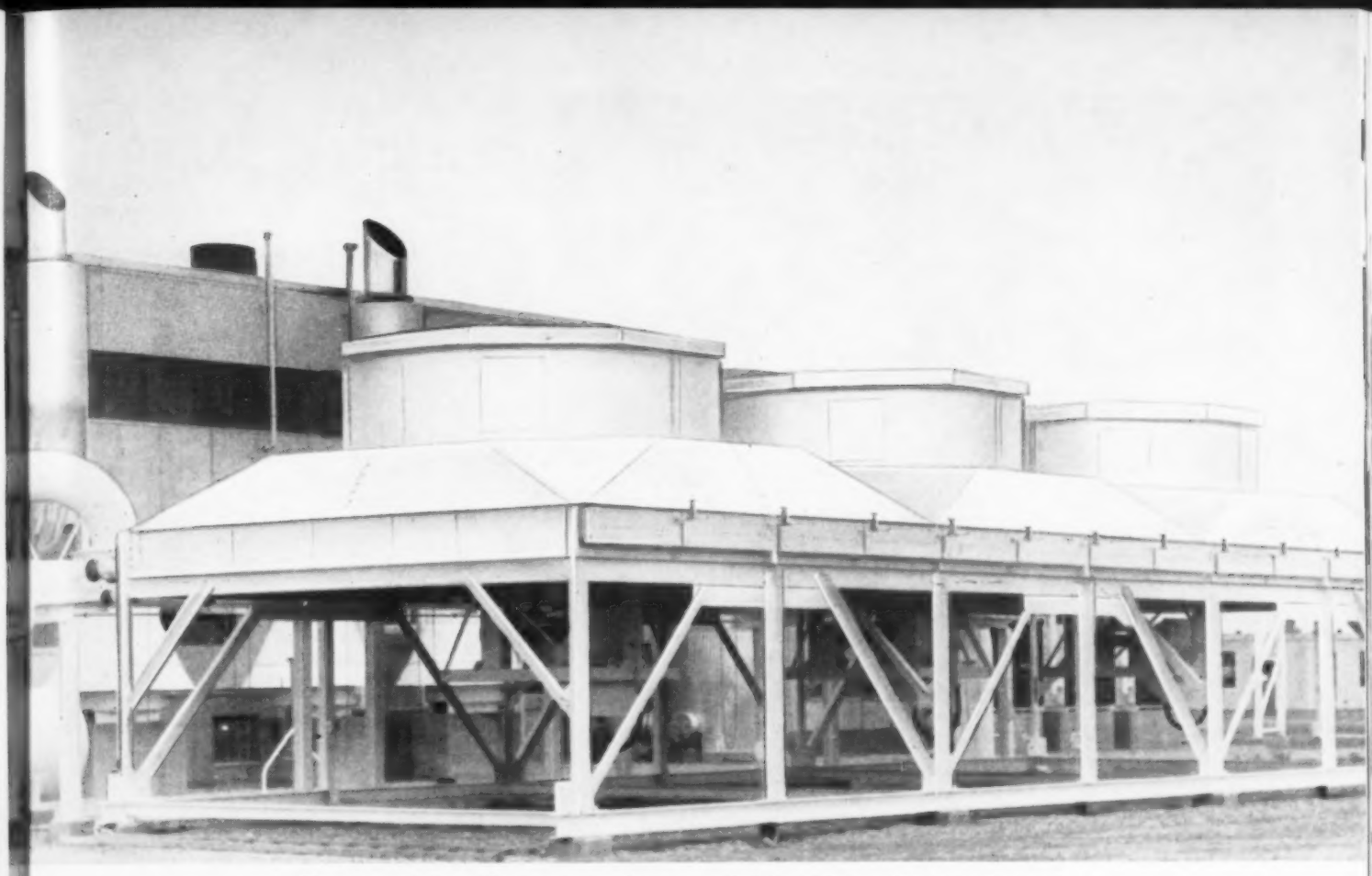


Giant compressor and generator engines are cooled by 26 TRANE Fluid Coolers at 6 Trans-Canada stations. Both horizontal and vertical air discharge types are used.

Trans-Canada, longest gas pipeline in the world, chooses Trane Fluid Coolers to cool engine water!

The Trans-Canada Pipeline System—2,294 miles long—provides market outlets for reserves of Alberta natural gas, serves Western Canada, and the great industrial areas of Eastern Canada.

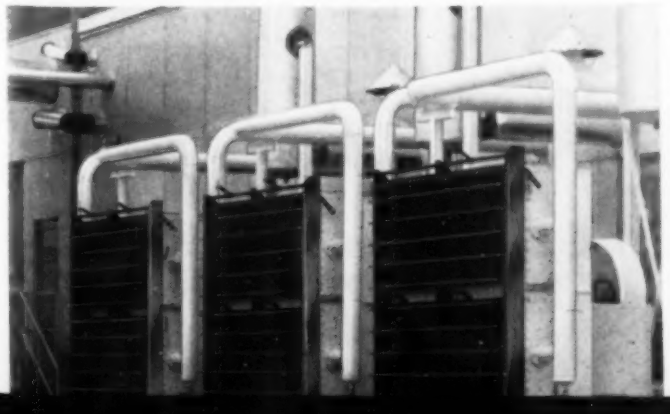
Because this pipeline passes through country where winter temperatures are very low, it was necessary to install engine jacket water cooling equipment that would function at 40 degrees below zero!

Trans-Canada chose TRANE Fluid Coolers for this important job. 26 TRANE units serve the initial six compressor stations. Air cooling was considered essential—and TRANE Fluid Coolers have shown that they can operate efficiently under all weather conditions.

More and more transmission companies are turning to TRANE for cooling equipment. Many have reported simplified maintenance, a minimum of adjustment problems. And engineers *know* that they can depend upon the accuracy and completeness of TRANE capacity ratings—tested in the industry's most complete laboratory, where as many as 90 different temperature readings are taken across the face of a heat transfer section!

When you have a fluid cooling problem, turn to TRANE! Just call your nearby TRANE Sales Office—or write TRANE, La Crosse, Wisconsin.

Small TRANE Horizontal Air Discharge Coolers cool the engines used to drive the 250-kilowatt generators (three per station) which supply electrical power on stations not served by a utility.



For any air condition, turn to

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MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING, VENTILATING AND HEAT TRANSFER EQUIPMENT

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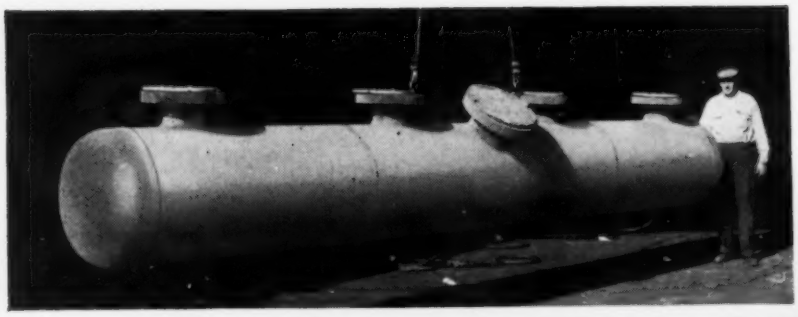
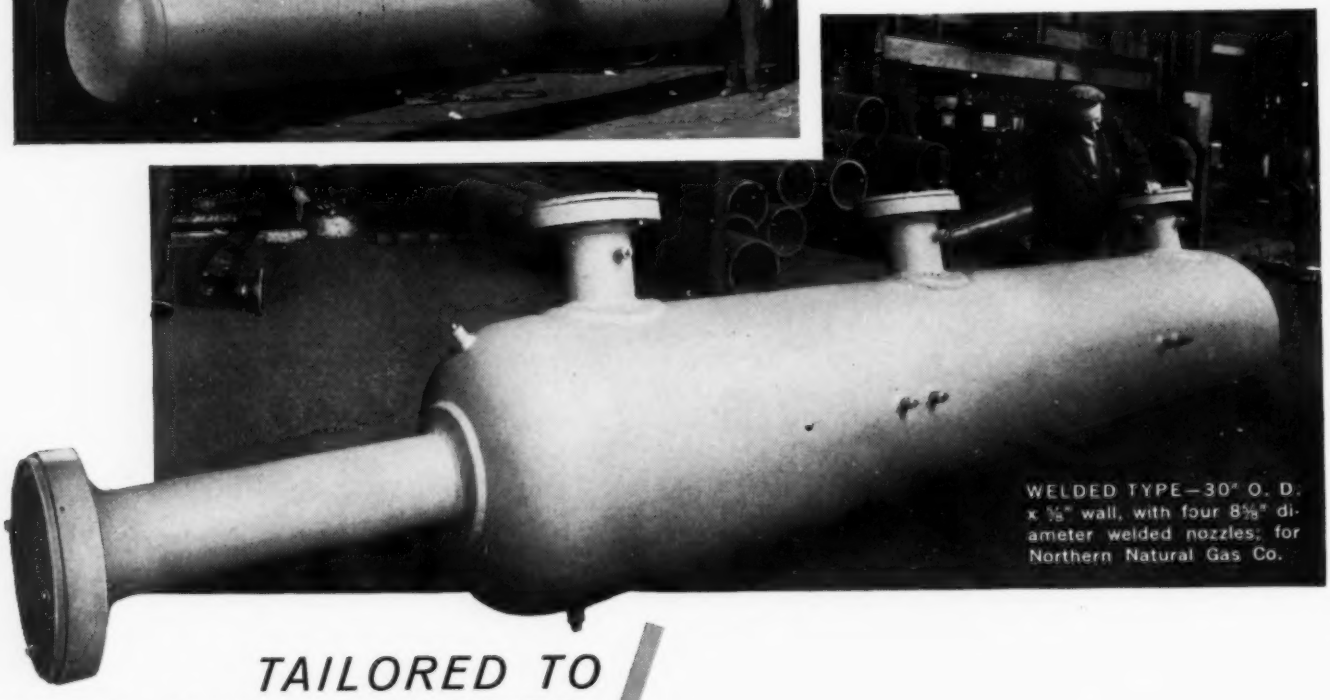


EXTRUDED TYPE—30" O. D. x 1¼" wall, with four 8" and one 12" diameter extruded nozzles; for Peoples Gulf Coast Natural Gas Pipeline Co.



WELDED TYPE—30" O. D. x ⅜" wall, with four 8⅝" diameter welded nozzles; for Northern Natural Gas Co.

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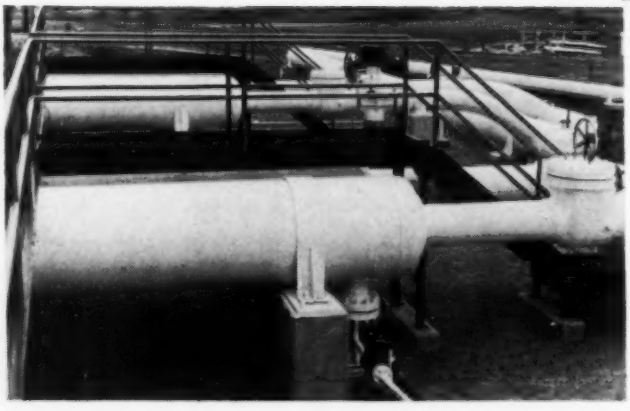
MIDWEST PULSATION DAMPENERS



Midwest—fabricated 34" pulsation dampener installed at Texas Gas Corporation's compressor station at Slaughters, Kentucky.

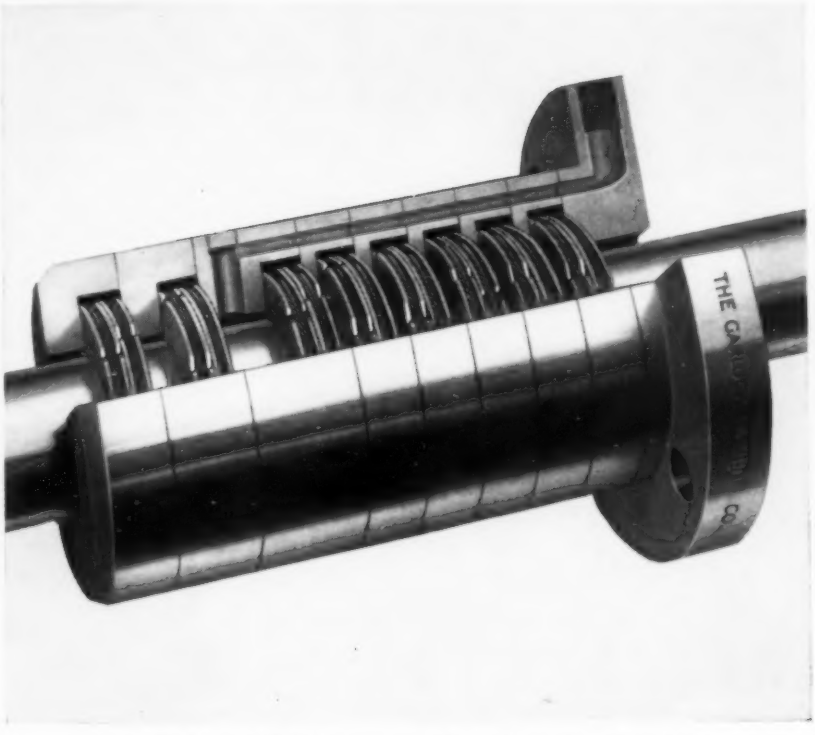
In any size or wall thickness, for operation at pressures up to 900 pounds or more, in Tri-Ten, A-212-B steel or any other weldable metal / Welded nozzle or extruded nozzle construction / Fabricated to code requirements / Excellent quality—long life / Dependable delivery—four fabrication plants across the nation. Send us details for quotation on your pulsation dampener requirements.

TODAY! Write for NEW bulletin 60-C describing Midwest Seamless and Welded-type fittings.

MIDWEST

MIDWEST PIPING CO., INC.
1450 South Second Street • St. Louis 4, Mo.

ENGINEERED PACKINGS for Pipe Lines



Garlock Metal Packings are supplied with segmental packing rings super-finished to 10 micro-inches or less for better sealing

IDEAL FOR UNATTENDED COMPRESSOR STATIONS

Garlock Metal Packings assure you of long-lasting, leak-free sealing at automatic stations hundreds of miles away. Once installed, metal packings can be forgotten . . . give you years of trouble-free operation!

Every metal packing set that leaves the Garlock factory must meet the following rugged standards:

1. Gas tight seal between packing rings and compressor rod.
2. Gas tight seal between packing rings and packing groove.
3. Packing must not be affected by operating conditions.
4. Operating conditions must not be affected by packing.
5. Packing must have no adverse effect on compressor rod.

Garlock Metal Packing Rings have a surface finish of 10 micro-inches or less . . . flatness of the rings is measurable in light bands—these facts add up to a more positive seal between ring and groove. This exclusive Garlock advantage has been made possible through improved manufacturing technique and is offered to you without additional cost. Metal packing rings are available in Graphitic Cast Iron, Bronze, Carbon, Babbitt, Amberite, and Teflon—they are precision made to exact specifications of size and finish to assure maximum efficiency.

Get these fine features by specifying Garlock metal packings. Choose from many different styles and materials. Whichever you select, you can be sure of the finest metal packing available for compressor service.

Discuss application details with your local Garlock representative. He's located at one of Garlock's 26 sales offices and warehouses throughout the U. S. and Canada. Or, write for Catalog AD-166. Garlock Inc., Palmyra, N. Y.

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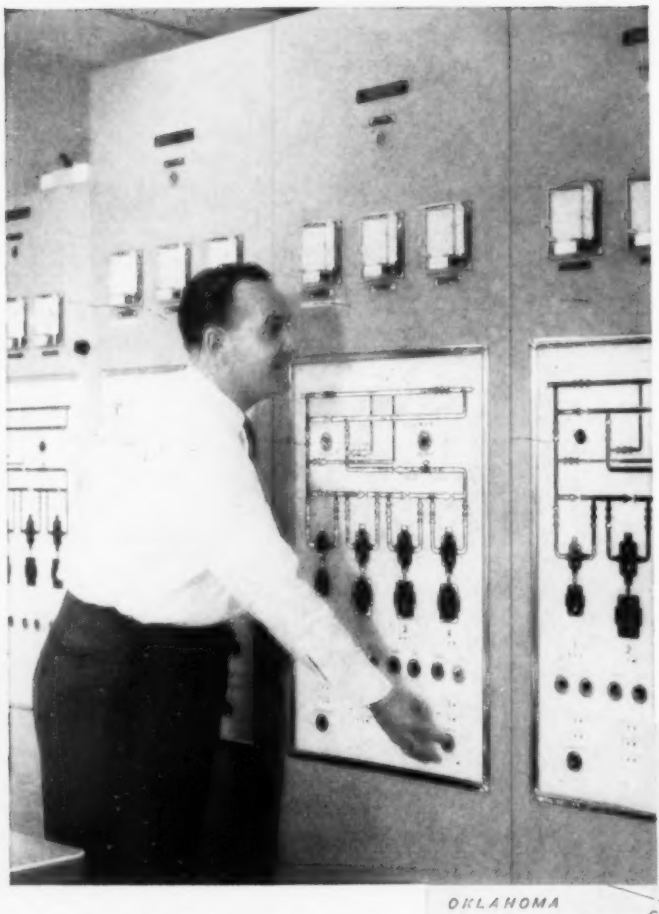
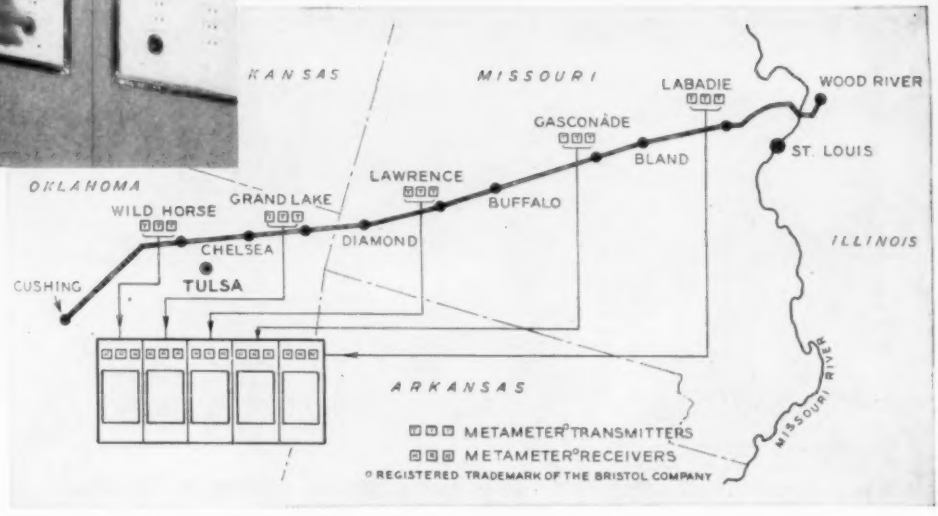
Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded & Extruded Rubber, Plastic Products.

GARLOCK

Bristol telemetering "mans" half the stations on 400-mile crude oil pipeline



Miniature Bristol Metameter* Telemeter Recorders (top row) on central supervisory control panel at Cushing office of Shell Pipe Line Corporation. Instruments, occupying only 5"x5¼" on panel, indicate and make permanent record of suction, case, and discharge pressure at each of five unmanned stations along 400-mile pipe line. (See map.)



Bristol Metameter* system permits efficient, instantaneous supervision from central office, frees valuable personnel from routine duties.

Midcontinent Division of Shell Pipe Line Corporation, Houston, Texas, uses a Bristol Metameter System for telemetering on the Ozark Pipe Line System, a 400-mile pipe line from Cushing, Oklahoma, to Wood River, Illinois. This system is jointly owned by Shell Pipe Line Corporation and The Texas Pipe Line Company and is operated by Shell Pipe Line.

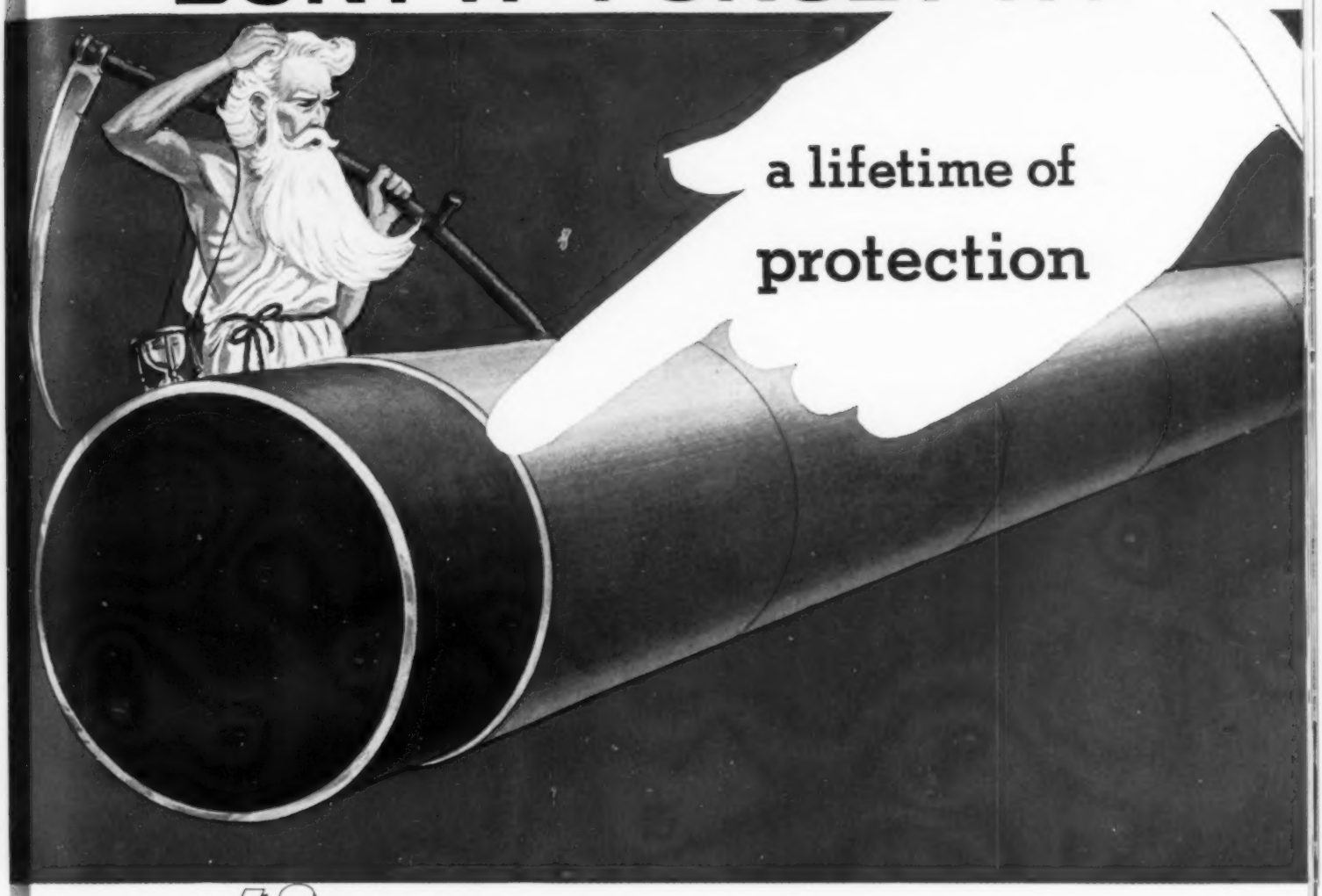
The Bristol Metameter telemetering system brings pressure readings from five unmanned pumping stations (out of 10 stations in all) along the pipe line into the central dispatching office in Cushing, Oklahoma. (See map.) Using the telemetered readings, the Cushing office can exercise complete supervisory control over pump operation at the unattended stations. Every other station along the line is manned, including the junction point, Cushing, and the terminus at Wood River. This puts personnel within a reasonable distance to take corrective action if trouble develops.

Whether they're used on oil pipe lines, natural gas pipe lines or distribution systems, electric power systems, water plants, or in steel mills or other industrial plants, Bristol telemeters can practically always improve operating efficiency and cut costs. Their accurate, precise readings are transmitted with the speed of radio (VHF, UHF, microwave), or telephone or carrier current lines for distances that may vary from a few yards to hundreds of miles. Pressure, liquid level, flow (including total corrected flow), temperature, mechanical motion, voltage, current, and power are just a few of the variables that can be transmitted.

Bristol developments in industrial telemetering, soundly based on more than 45 years' experience in this field, are making possible today a speed and an effectiveness in central supervisory control that would have been undreamed of only a few years ago. Let us give you full details. Write: The Bristol Company, 114 Bristol Road, Waterbury 20, Conn.

**T. M. Reg. U. S. Pat. Off.* O-19

BURY IT–FORGET IT!



time tells a tale of pipeline protection permanence!

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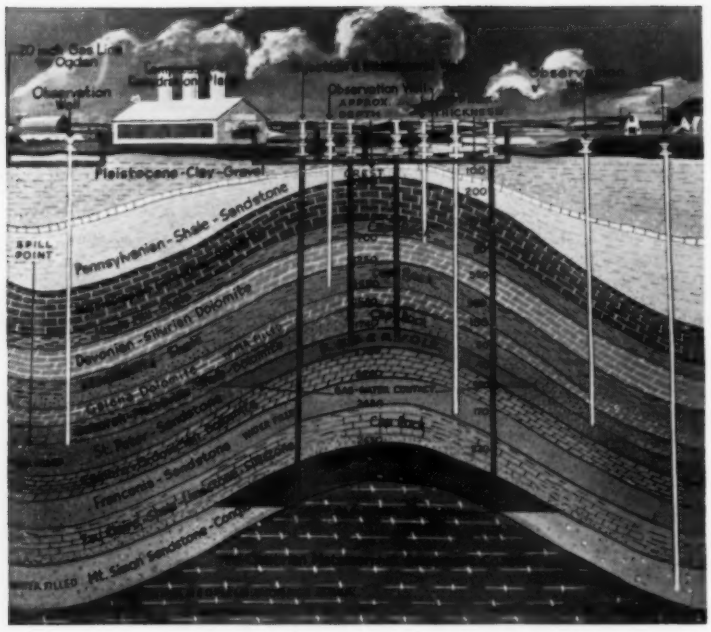
Even where highly corrosive soil conditions exist, PLS coated and wrapped pipe installed underground for many years reveals a complete absence of corrosion. A surface as rust-free as the day it came from the mill . . . positive proof of the protective value of PLS service. Time proves its permanence! So why not make sure your next coating and wrapping job is done the time-tested PLS way? There's a PLS plant conveniently located to meet your processing requirements and to assure positive delivery WHEN you need it . . . WHERE you need it. Write today for complete information.

Pipe Line Service Corporation

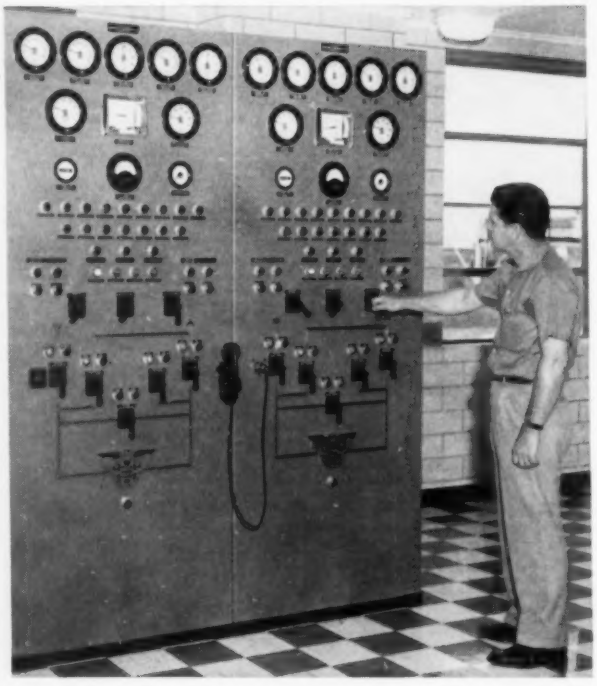
A SUBSIDIARY OF AMERICAN STEEL FOUNDRIES

General Offices and Plant: Franklin Park, Ill.

Quality pioneers in coating and wrapping pipe for over a quarter century

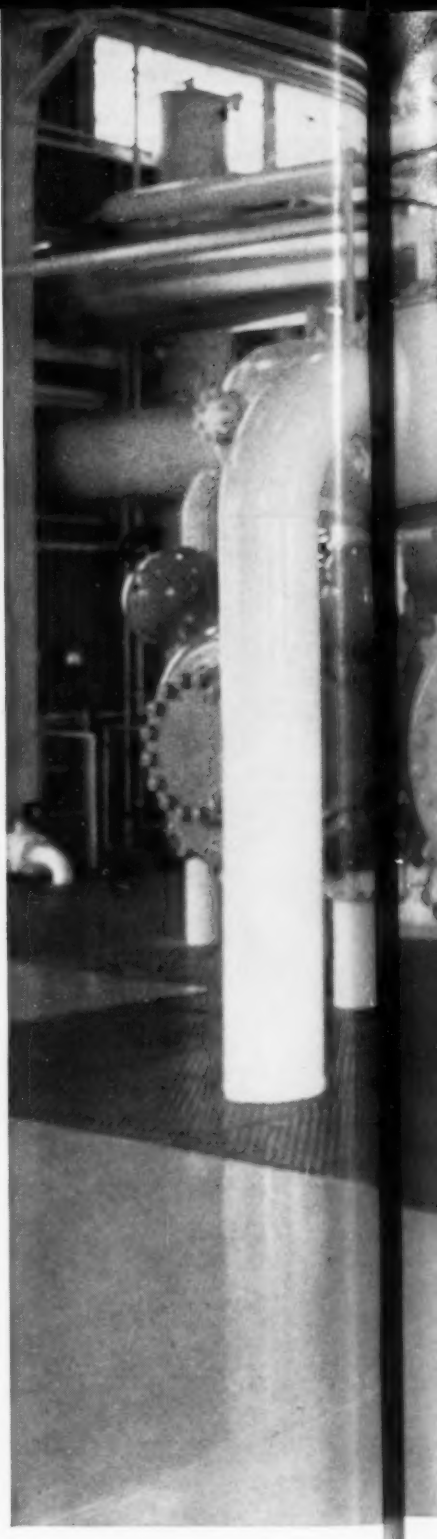


▲ Cutaway drawing of underground storage reservoir at Redfield. This station injects into St. Peter and Mt. Simon sandstone at 59 wells. Ultimate capacity of both strata is about 140 billion cu. ft.



M. H. Raven (right), Superintendent of ▶ Northern Natural Gas Company's underground storage compressor station near Redfield, Iowa, until his recent promotion, discusses the facts with H. E. Hansen, Shift Engineer. Compressor in foreground is GMWA-8, rated 2000 hp. Another similar unit is in the background.

◀ Cooper-Bessemer En-Tronic control provides complete start-stop, loading–unloading automation for the engine driven compressor.



How a rugged compressor aids a variable-load gas storage program

During its first year's operation, Redfield Station of Northern Natural Gas Company has been put through a rigorous test. According to M. H. Raven, Superintendent, "Our Cooper-Bessemer GMWA-8 Compressor and En-Tronic Control have responded round-the-clock to this program of normal loading, underloading and overloading with remarkable performance. Despite abnormal loading, oil consumption and water usage have been very low. Inspection and cleaning after 12,000 hours showed all parts in perfect condition. It is a *rugged* machine!"

Call our nearest office for help in applying this kind of dependability and load flexibility to *your* compressor operations.

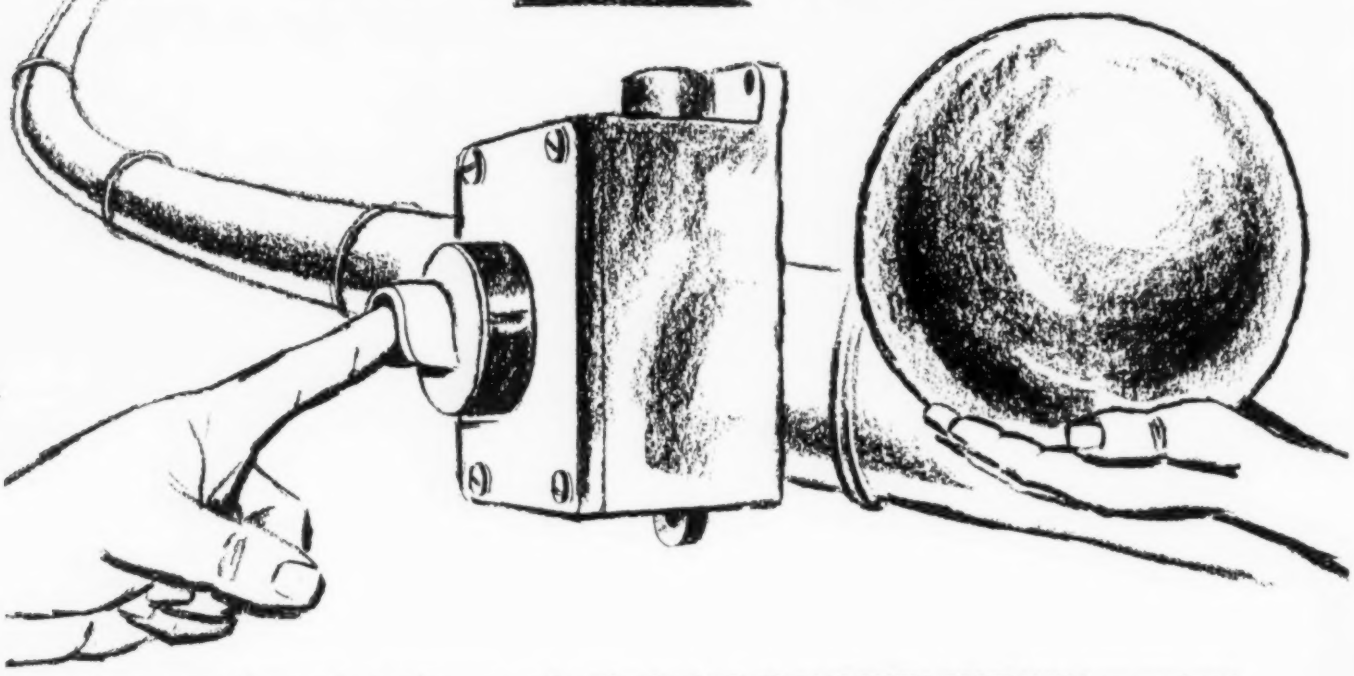
BRANCH OFFICES: Grove City • New York • Washington Gloucester • Pittsburgh • Detroit • Chicago • Minneapolis • St. Louis Kansas City • Tulsa • New Orleans • Shreveport • Houston Greggton • Dallas • Odessa • Pampa • Casper • Seattle San Francisco • Los Angeles • SUBSIDIARIES: Cooper-Bessemer of Canada, Ltd. . . . Edmonton • Calgary • Toronto • Halifax Stratford • C-B Southern, Inc. . . . Houston • Cooper-Bessemer International Corporation . . . New York • Caracas • Anaco • Cooper-Bessemer, S.A. . . . Chur, Switzerland • The Hague, Netherlands Mexico City • The Rotor Tool Company, Cleveland

Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS - DIESEL - GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINE, TURBINE OR MOTOR DRIVEN

PIPELINE
SPHERE AUTOMATION
.... at YOUR FINGERTIP *



Seven years of research, development, and testing by the F. H. MALONEY COMPANY have produced a successful pipeline Sphere, proven in actual field operations. In three years of further development, MALONEY has perfected the components of a completely automatic pipeline system, for product separation, meter proving, two-phase operations — among others, made possible by the unique characteristics of the MALONEY Sphere.

AUTOMATIC LAUNCHING
A completely automatic launching system takes full advantage of the spheroid shape. Launching barrels can be placed anywhere on the line and can be operated manually or automatically and remotely for the insertion of as many spheres as are needed, based on rates of time, flow, or other requirements.

AUTOMATIC METER-PROVING
(Shell Development Company — U.S. Patent No. 2772561) Complete push-button control provides a fully automatic system, up to and including read-out equipment, or any part thereof. The MALONEY system avoids product contamination for it is an *integral part of the operating pipeline* and not merely an adjunct. With the MALONEY automatic system, Meter-Proving is accomplished under operating pipeline conditions. Proving can be accomplished from remote locations without local labor.

***AUTOMATIC PRODUCT SEPARATION**
(Shell Development Company— U.S. Patent No. 2953157) Even the push button can be eliminated — for product separation *can now be* fully automated. The separation can be controlled completely by those factors which introduce contamination into the line, such as valve sequencing, manifolding, etc.

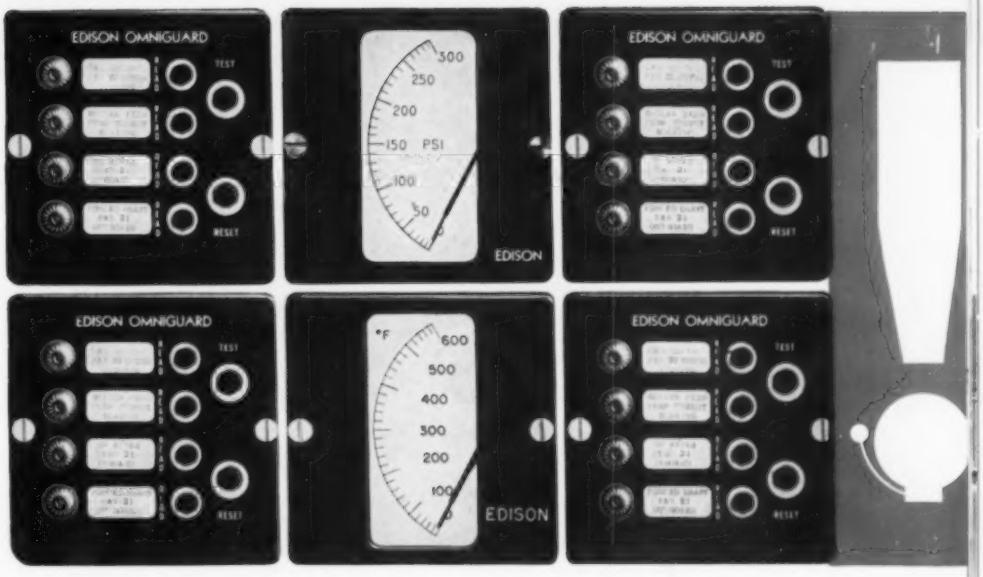
MALONEY does not sell an off-the-shelf system, since pipeline conditions vary. Each application is precision-manufactured for the specific job. However, MALONEY stocks all basic components which, through precision design and manufacture, can be interchanged readily throughout the entire MALONEY automatic pipeline system. These on-hand units are available for immediate maintenance work, thus minimizing down time if maintenance problems occur.

The MALONEY COMPANY can design and manufacture *any* phase of a fully automated system, utilizing the pipeline sphere. MALONEY engineers are fully qualified to design and manufacture to meet your specific application and follow through with experience-proven equipment.

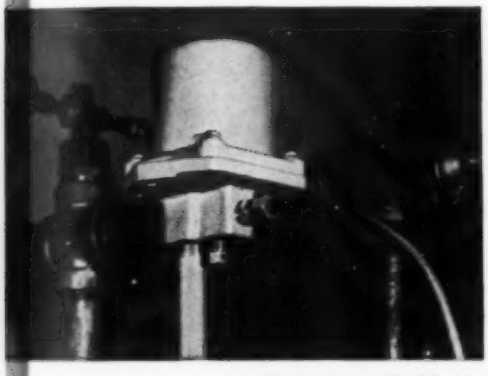
F. H. MALONEY
COMPANY
P. O. BOX 1777 • HOUSTON, TEXAS
CHICAGO • LOS ANGELES • PITTSBURGH • TULSA

F. H. Maloney COMPANY ®

GUARD ALL CRITICAL PRESSURES AND TEMPERATURES WITH THOMAS A. EDISON LOW-COST, OMNIGUARD WARNING SYSTEM



Here is a versatile, highly-reliable continuous warning and monitoring system. By simply pushing a button on this panel you obtain a reading of *key pressure* and *temperature* points throughout your plant. In addition, this system provides instantaneous warning when pressure or temperature deviates from pre-set limits.

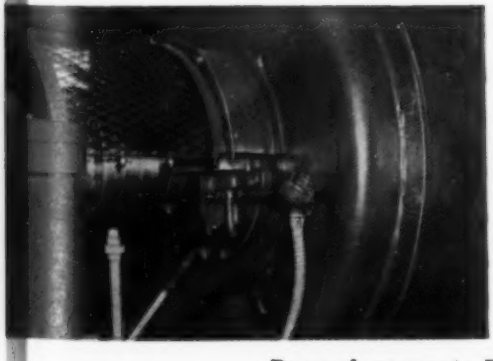


PRESSURE

With the Edison Omniguard system you can monitor gas, fluid or vapor pressure. Heart of the system is a rugged, accurate, pressure detector which converts pressure directly to electrical resistance—requires no millivolt conversion—no amplifier. For pressures under 60 PSI a precision capsule is the sensing element. From 60 to 3000 PSI special bourdon tube elements are used.

When pressure changes, resistance varies and this deviation is transmitted to the control panel. Units operate over ambient temperatures of 32° to 150°F. Control panels are available with a wide variety of scales and are equipped with both normally open and normally closed alarm contacts to operate any type of auxiliary device or to automatically shut down machinery or process.

Compact, reliable Resistance Pressure Detector transmits changes in pressure to central control panel.



TEMPERATURE

Edison Omniguard also provides reliable protection from overheating. You can monitor the temperature of bearings, gases and liquids in critical equipments or processes. Reliable Edison Resistance Temperature Detectors have no moving parts and give instantaneous warning when limits are exceeded. Unlike other systems which only scan, Omniguard is continuously monitoring. You can obtain exact readings of temperatures in all parts of your plant from one central control panel.

For greater flexibility and reliability each detector circuit is completely independent. If one circuit is damaged, all other circuits remain "on guard." When changes or additions are required they can be accomplished quickly and easily.

Rugged, accurate Resistance Temperature Detector guards against overheating of this motor bearing.

Thomas A. Edison Industries
INSTRUMENT DIVISION
95 LAKESIDE AVENUE, WEST ORANGE, N. J.

McGRAW EDISON

Valves, Fittings, Flanges... Rockwell-Nordstrom, OIC, W-K-M, Stockham, Taylor Forge... Line Pipe by Jones & Laughlin— these and other famous products from J&L Supply enable you to design and...

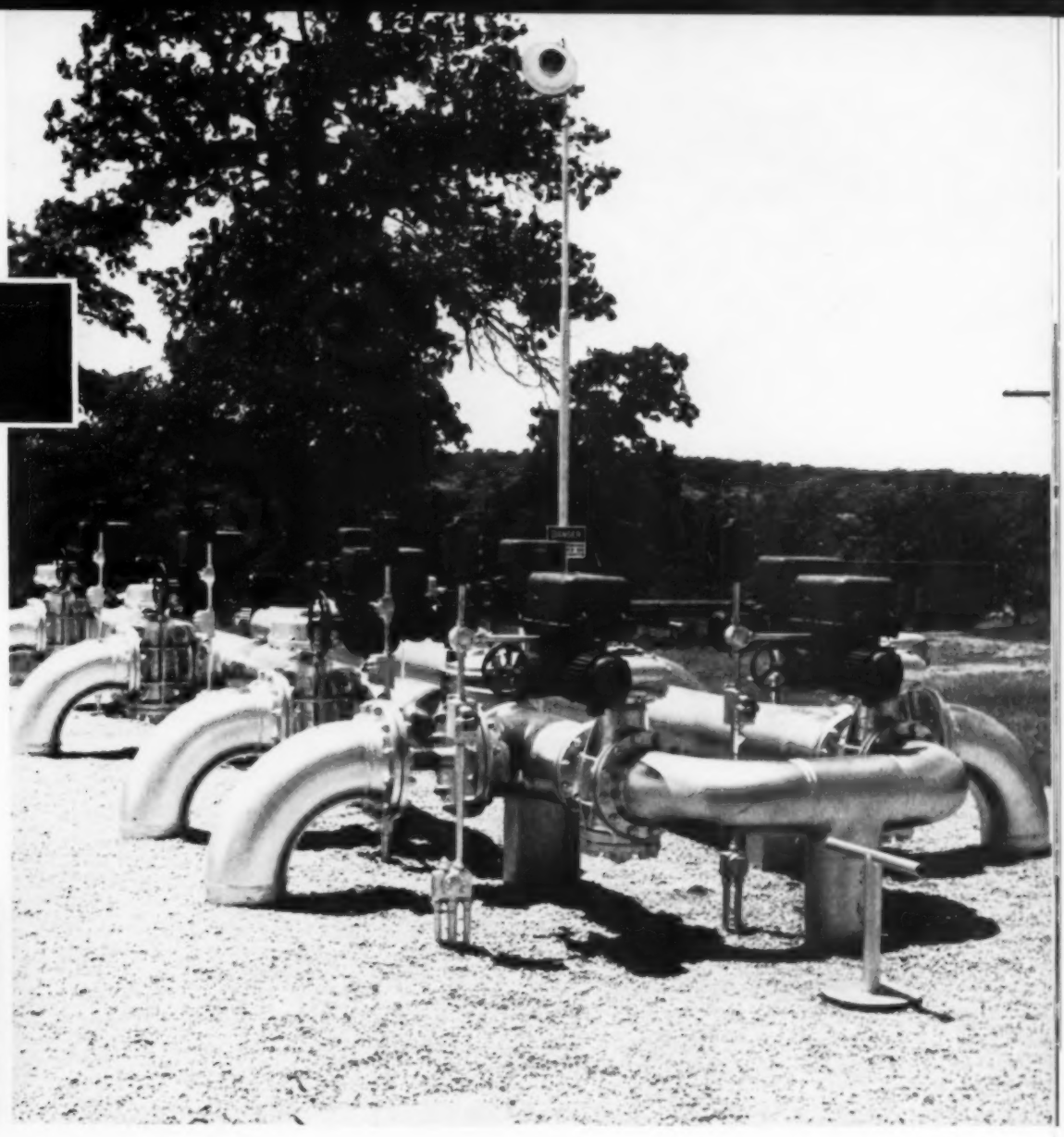
Build a Better Pipeline!

Fast, economical pipeline construction and dependable operation are assured with J&L Electricweld Line Pipe.

High ductility for easier field bending and ends that are uniformly round to line up quickly for fast, dependable welding will speed your lines across even the most rugged terrain.

Multiple testing of every length of J&L Electricweld Line Pipe assures top performance during installation and operation. J&L testing includes ultrasonic inspection of the weld area, hydrostatic pressure testing, visual inspections, flattening tests, and magnaflux examination of both ends of every joint.

J&L Electricweld is available in sizes from 6⅝" O.D. to 12¾" O.D. J&L Seamless Line Pipe is produced in sizes from 2⅜" O.D. to 14" O.D.



Above, Rockwell-Nordstrom valves doing sentinel duty on the manifold of a terminal at a products pipeline station. Flanges and welding fittings are by Taylor Forge.

Pipelines throughout the nation are constructed and maintained more economically with products sold by J&L Supply . . . the best available.

Ask your J&L Supply man for technical material on pipeline products.

Jones & Laughlin

SUPPLY DIVISION – Tulsa

If it's sold by J&L . . . .

It's the best available

LOWEST METERING COST PER BARREL

Standard $2,000 meters still on original calibration without maintenance after 65,000,000 barrels.

POTTERMETER* is the turbine type flowmeter with the patented *Floating Rotor* — its only moving part. The POTTERMETER* provides long term, trouble-free service for bulk plants, pipelines, refineries, loading racks and airport fueling operations. It is ideal for automatic custody transfer.

STANDARD POTTER EQUIPMENT HANDLES FROM ONE TO 30,000 AND MORE BARRELS OF OIL PER HOUR

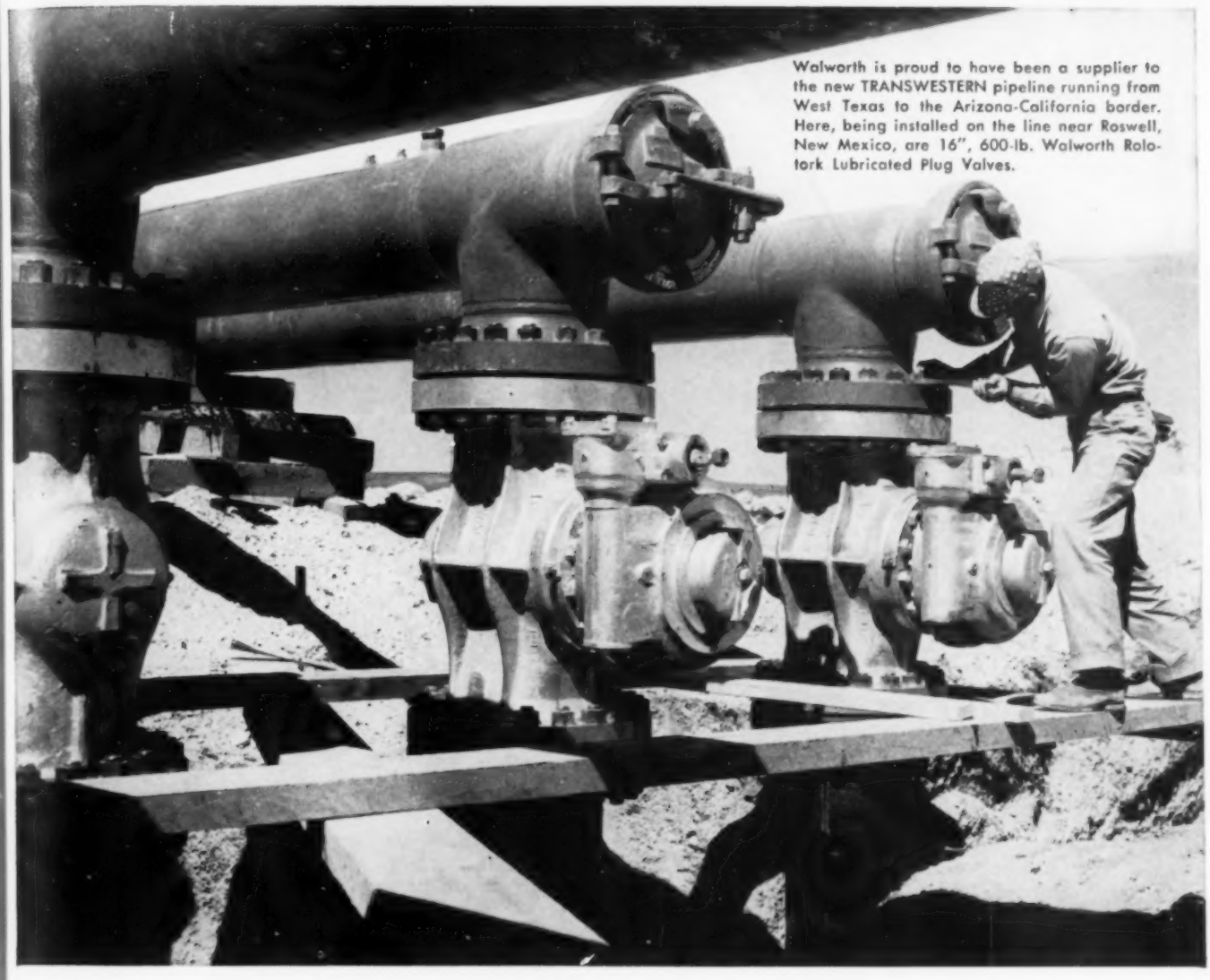
Extremely accurate, the POTTERMETER* is easily installed. It is relatively light in weight and no larger than the line in which it operates. Totalizers may be located hundreds of feet away from the meter itself. For details write to Dept. P.W.

*TRADE MARK

POTTER engineered

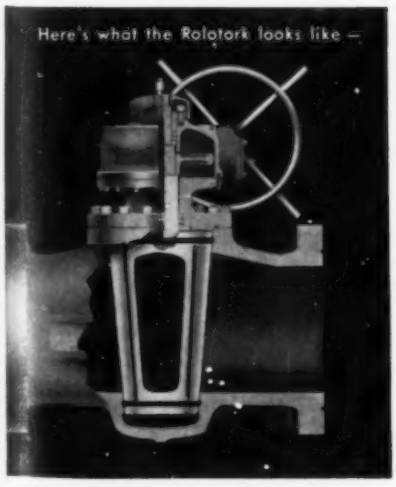
pottermeter co.

Union, New Jersey MUrdock 6-3010



Walworth is proud to have been a supplier to the new TRANSWESTERN pipeline running from West Texas to the Arizona-California border. Here, being installed on the line near Roswell, New Mexico, are 16", 600-lb. Walworth Rolotork Lubricated Plug Valves.

RELY ON *ROLOTORK* ...BY WALWORTH



No matter what the service, you can rely on the Walworth Rolotork Lubricated Plug Valve to operate easily and dependably in handling gas, crude or finished petroleum products. In service throughout the world, these valves have proved their complete dependability. Why? Because Walworth manufactures a *better* LPV.

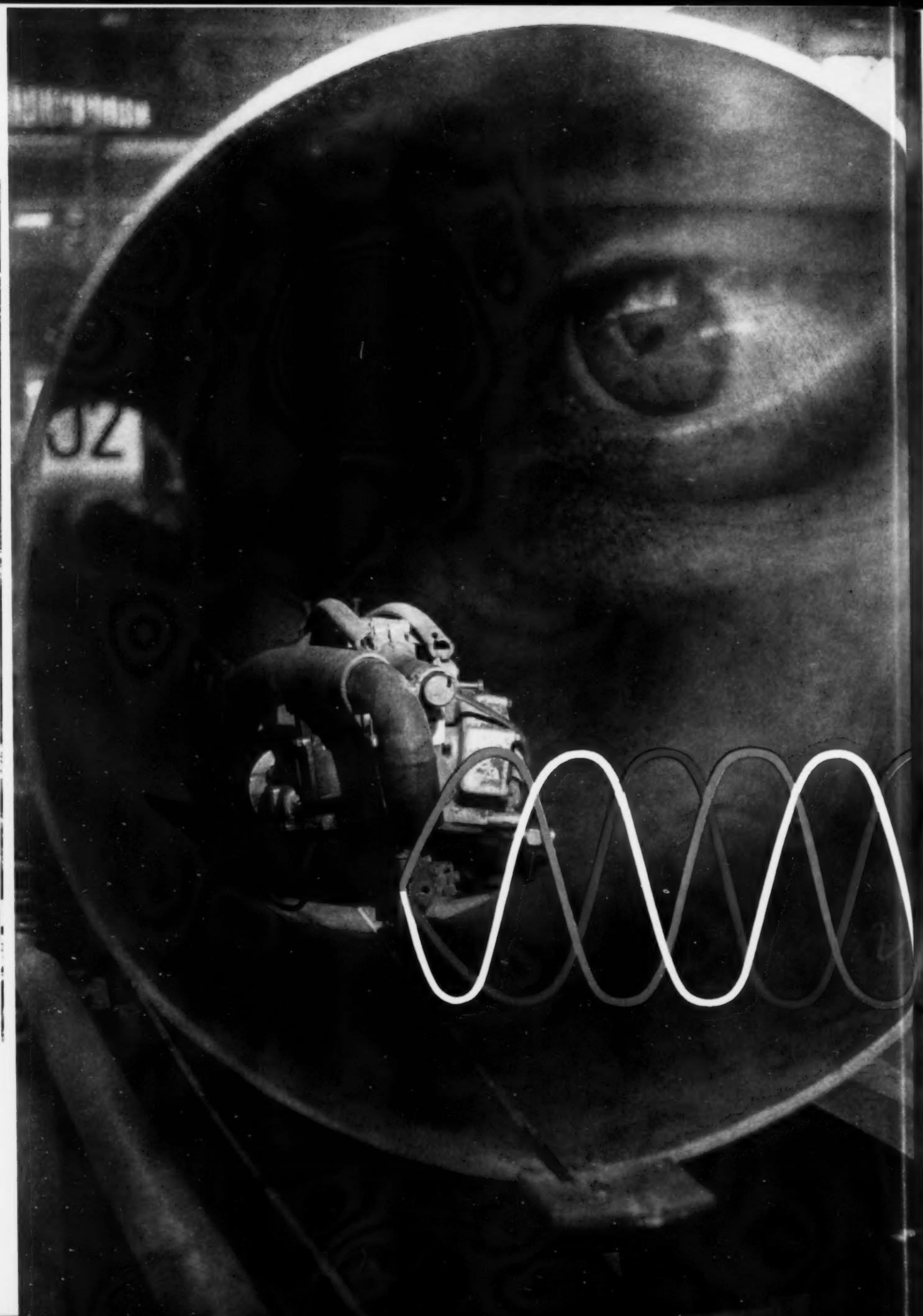
The Rolotork turns more easily, closes tighter, and requires less maintenance. It can be lubricated without removing the lubricant fitting. The gear housing design permits simple attachment of lubrication and handwheel extensions without modifying the gearcase. And vertical and circumferential lubricant grooves completely frame the port openings, preventing leakage.

These are just some of the features that make Walworth LPV's better. For additional information, write Walworth Company, Lubricated Plug Valve Division, 3517 Polk Avenue, Houston 23, Texas.

WALWORTH *750 Third Avenue, New York 17, N. Y.*

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

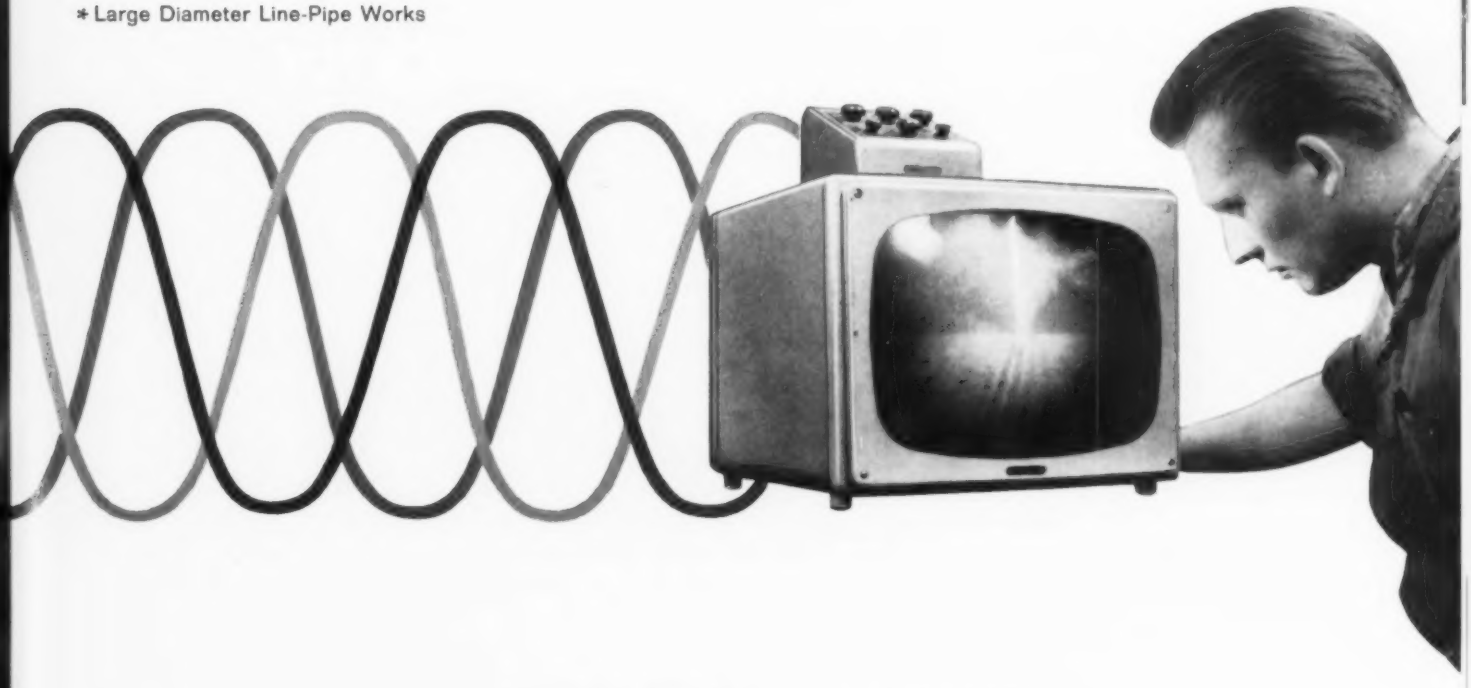
WALWORTH SUBSIDIARIES: ALLOY STEEL PRODUCTS CO. • CONOFLOW CORPORATION • GROVE VALVE AND REGULATOR CO. M&H VALVE & FITTINGS CO. • SOUTHWEST FABRICATING & WELDING CO., INC.



A private eye inside a line-pipe

This private eye at Großrohrwerk Mannesmann-Hoesch* is an electronic one and therefore able to watch every inch of the seam continuously from the inside during longitudinal welding. Control by TV is the most efficient way to ensure that you shall not have to dig up any section of your new Mannesmann-Hoesch pipelines. However, it is not the only way of testing; ultrasonic, magnetic, and X-ray methods are also available.
A whole team of experts also constantly watches every production process. Production of all Mannesmann-Hoesch line-pipes, from 6 5/8" to 42", is so thoroughly automated at all stages that human error is practically eliminated.

* Large Diameter Line-Pipe Works



Laying pipelines costs money –
digging them up costs more!

Please write for detailed information to

MANNESMANN EXPORT · DÜSSELDORF/GERMANY

Introducing

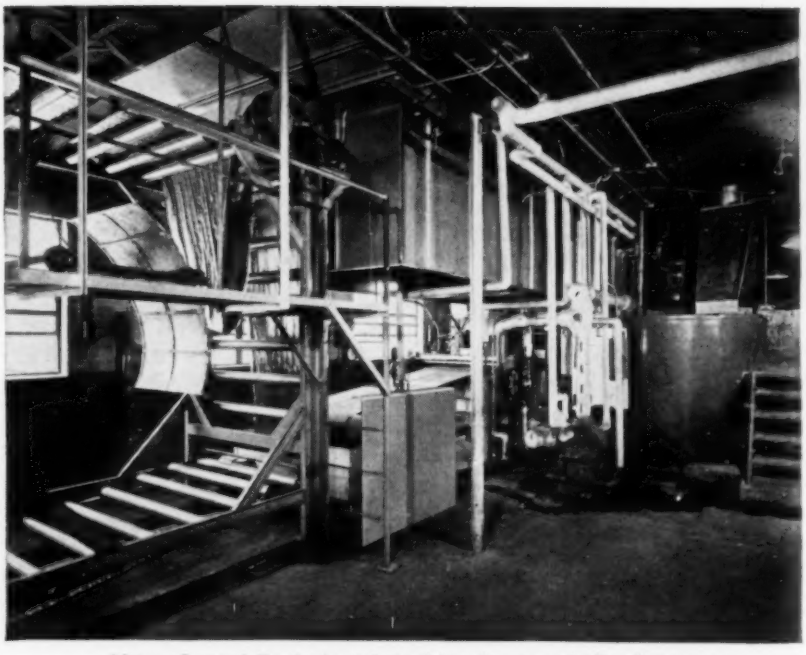
TAPECOAT® 20

(Exploded View)

A Coal Tar TAPECOATing that Provides Single-Wrap Protection **PLUS** an Outer Wrap

- ★ It's more than just a coal tar coating!
- ★ It's designed for single-thickness application!
- ★ It has advanced features of uniformity!
- ★ It assures greater coverage!
- ★ It includes a tough outer wrapper!
- ★ It combines 20 years of manufacturing and field application experience!
- ★ It gives superior protection with greater economy!

Write for the complete details today.



View of specially-designed machine developed after five years of research by Tapecoat engineers to convert raw materials automatically into TAPECOAT 20.

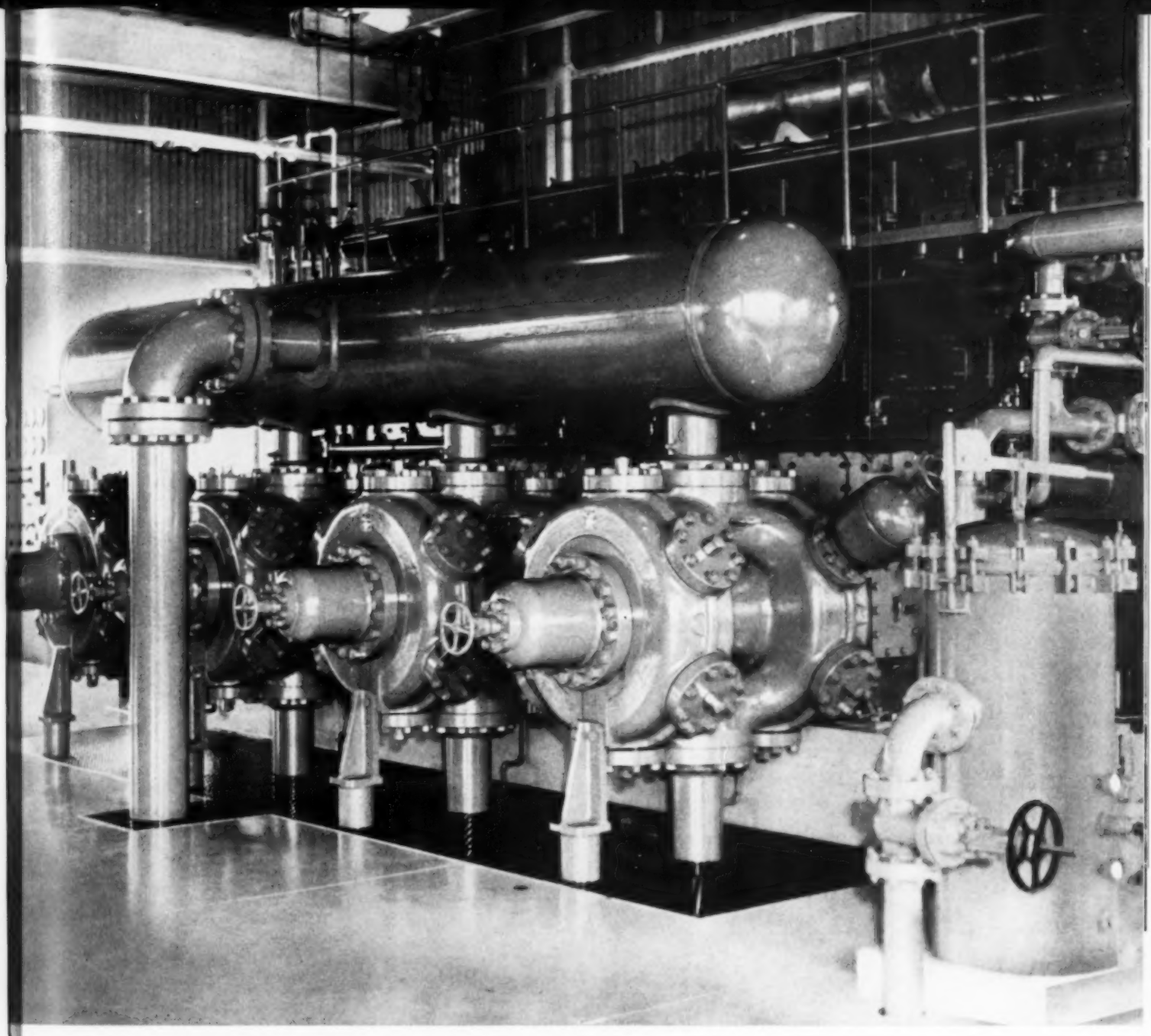
The TAPECOAT *Company*

ORIGINATORS OF COAL TAR COATING IN TAPE FORM

1537 Lyons Street, Evanston, Illinois

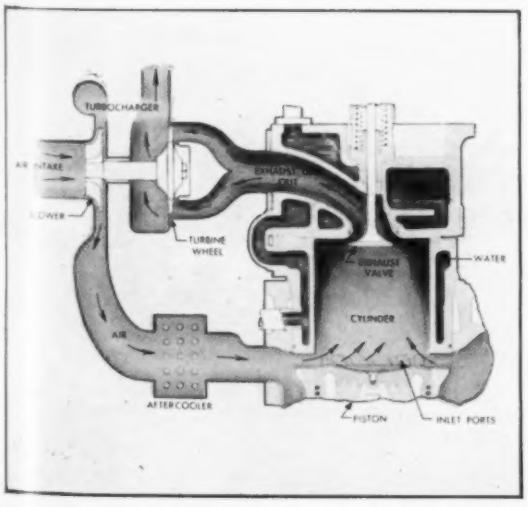
Telephone: DAvis 8-5220

Sales and Service Offices in New York, Pittsburgh, Charlotte, Birmingham, Houston, Lincoln, Tulsa, Minneapolis, Salt Lake City, San Francisco, Los Angeles, Seattle



At Northern Natural's Clifton Station, this SUTC engine compressor operates

20 HOURS A DAY...FOR 3 STRAIGHT YEARS



Self-sustained turbocharging at any speed and load is possible because of SUTC's exclusive Uniflo scavenging.

Five years ago a remarkable new engine compressor was introduced.

Called the SUTC, this Worthington turbocharged 2-cycle engine compressor was unlike any other. Combustion air enters thru side inlet ports, *but the exhaust is thru overhead valves.* Valve timing can be arranged to give maximum supercharging effect.

On paper, straight-thru or "Uniflo" scavenging has many advantages. The turbocharger operates over the entire speed and load range without help from external sources. Scavenging efficiency is increased and pulsations practically eliminated.

Now came the real test. More than 130,000 hp were installed. Operators praised the SUTC's exceptionally smooth, quiet operation. Operational records confirm the machines reliability. Unit G-2312 is typical. This 8 cylinder, 2000 hp SUTC engine compressor was installed in 1957 in Northern Natural Gas Company's Clifton, Kansas Station. To date, it has logged over 20,000 hours—an average of more than 20 hours a day for 3 straight years. A sister unit installed last year has equalled this performance.

May we send you complete data on this unique engine compressor? Please write to H.C. Barten, Worthington Corporation, P.O. Box 953, Buffalo 5, N.Y.

WORTHINGTON

THE WORLD GETS BIGGER EVERY DAY

As science makes the world smaller, it enlarges it in opportunity. Nucleonics, electronics, petrochemistry... these and other growing industries were unknown only 25 years ago.

The progress of natural gas and oil has been as dramatic. For one example, Tennessee Gas began operations just 16 years ago. Today, we transport over 2 billion cubic feet of natural gas daily through 12,000 miles of pipeline in 18 states. Explore for and produce gas and oil from Canada to South America. Refine petroleum and market its products in 23 states. We are active in petrochemicals and research.

More than ever, gas and oil spell... opportunity.

TENNESSEE GAS TRANSMISSION COMPANY

FROM NATURAL GAS AND OIL...HEAT, POWER, PETROCHEMICALS THAT MEAN EVER WIDER SERVICE TO MAN

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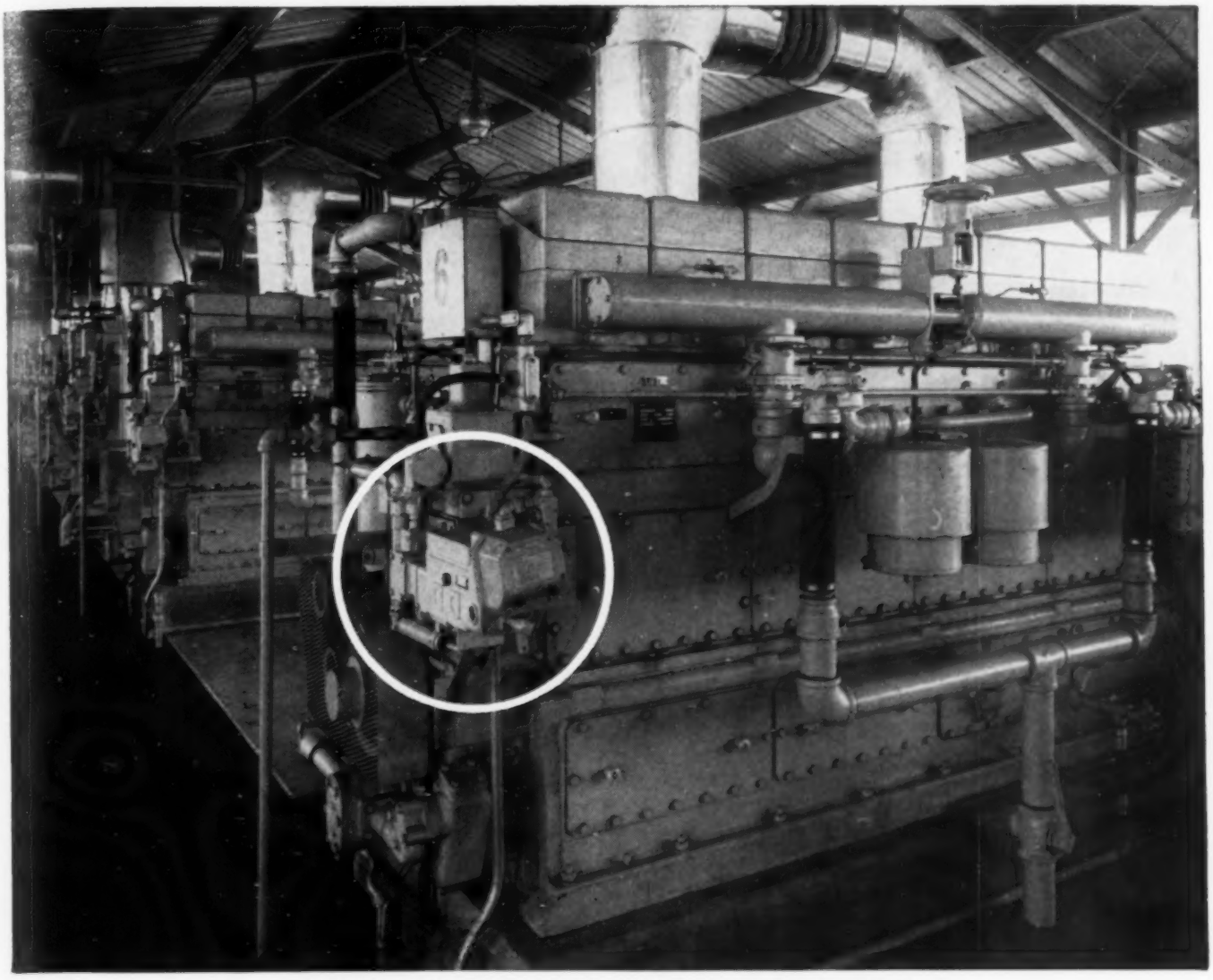
SUBSIDIARIES: Midwestern Gas Transmission Company • East Tennessee Natural Gas Company • Tennessee Life Insurance Company • AFFILIATE: Petro-Tex Chemical Corporation



Circle indicates Bendix LC magneto on White Superior engine at Long Beach.

BENDIX LC MAGNETOS HELP POWER GIANT LONG BEACH WATER-FLOODING PLANT

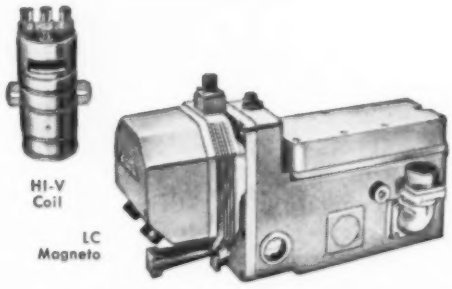
Long Beach, California, operates what may become the world's largest water-flooding plant—drawing water from the Pacific Ocean and pumping it into the Wilmington Tract beneath the city. The additional pressure created will aid in oil recovery and, it is hoped, will reduce land subsidence in the area.

Currently operating at a rate of 120,000 barrels per day, the capacity will be increased and may eventually reach 1,000,000 barrels per day—which would make it the world's largest project of its kind.

The plant is powered by eight White Superior gas engines equipped with Bendix* LC magnetos and HI-V transformer coils. These matched ignition systems, noted for long service life, simplified maintenance at low cost and complete operating reliability, can be used with engines of from six to sixteen cylinders.

If you want to know why major operators are specifying Bendix LC Ignition, write SCINTILLA DIVISION, BENDIX AVIATION CORPORATION, SIDNEY, NEW YORK.

*REG. U.S. PAT. OFF.



MATCHED IGNITION SYSTEM

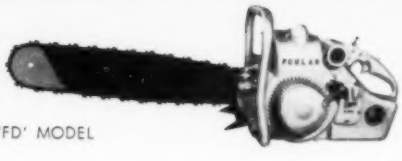
Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y. *Canadian Affiliate:* Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec. *Factory Branch Offices:* Burbank, Cal.; Orlando, Fla.; Chicago, Ill.; Teaneck, N. J.; Dallas, Tex.; Seattle, Washington; Washington, D. C.

Scintilla Division

SIDNEY, N. Y.

THE Bendix CORPORATION

CLEARIN' THE WAY?


'FD' MODEL

Use POULAN CHAIN SAWS . . . the money makin'est saw of 'em all! Alive with power and job engineered to handle those really tough jobs. Poulan saws have all the quality features that have made them the first choice of professional pipelinemen . . . rugged lightweight design, natural balance, smooth engine performance . . . features that add up to years of economical service . . . years of peak production with less downtime, less maintenance, more profits! You'll find that you make more money when you clear the way with POULAN CHAIN SAWS!

The new direct drive 'FD' will give you all the famous Poulan quality features of performance and dependability . . . durable aluminum alloy castings • larger spur • natural balance • positive oil pump • all position carburetor • roller and needle bearings • automatic clutch • enclosed carburetor • moisture and dust proof magneto; and all the economy you expect to get from Poulan Chain Saws!

See your local chain saw dealer for a Poulan demonstration today!

POULAN CHAIN SAWS

SUBSIDIARY OF BEAIRD-POULAN INC. • SHREVEPORT, LOUISIANA

Acme-Newport Steel

CONSTANT LABORATORY CONTROL . . .

PROVIDES QUALITY IN ELECTRIC WELD LINE PIPE

Metallurgists call every play in the production of steel at Acme-Newport. They provide the diet for gulping furnaces, check samples at every step. In addition to chemical and physical checks of the steel itself, line pipe undergoes flattening tests, visual and hydrostatic inspections . . . and a final examination by Acme-Newport's new electronic device that scans for defects invisible to the human eye.

Nothing less satisfies this Company and its customers. Let Acme-Newport serve you, too, with electric weld line pipe in 4″ and 6″ sizes, standard or thin wall.

Acme-Newport Steel COMPANY
NEWPORT, KENTUCKY
A SUBSIDIARY OF ACME STEEL COMPANY

SIZES AND WEIGHTS AVAILABLE

O.D.	Wall	Wt. Per Ft.
4½	.125″	5.84
	.142″	6.61
	.156″	7.25
	.188″	8.64
	.219″	10.00
	.237″	10.79
6⅝	.156″	10.78
	.188″	12.89
	.219″	14.97
	.250″	17.02
	.280″	18.97

NEW compressor-carrying steps-up "tack" and "hot-pass

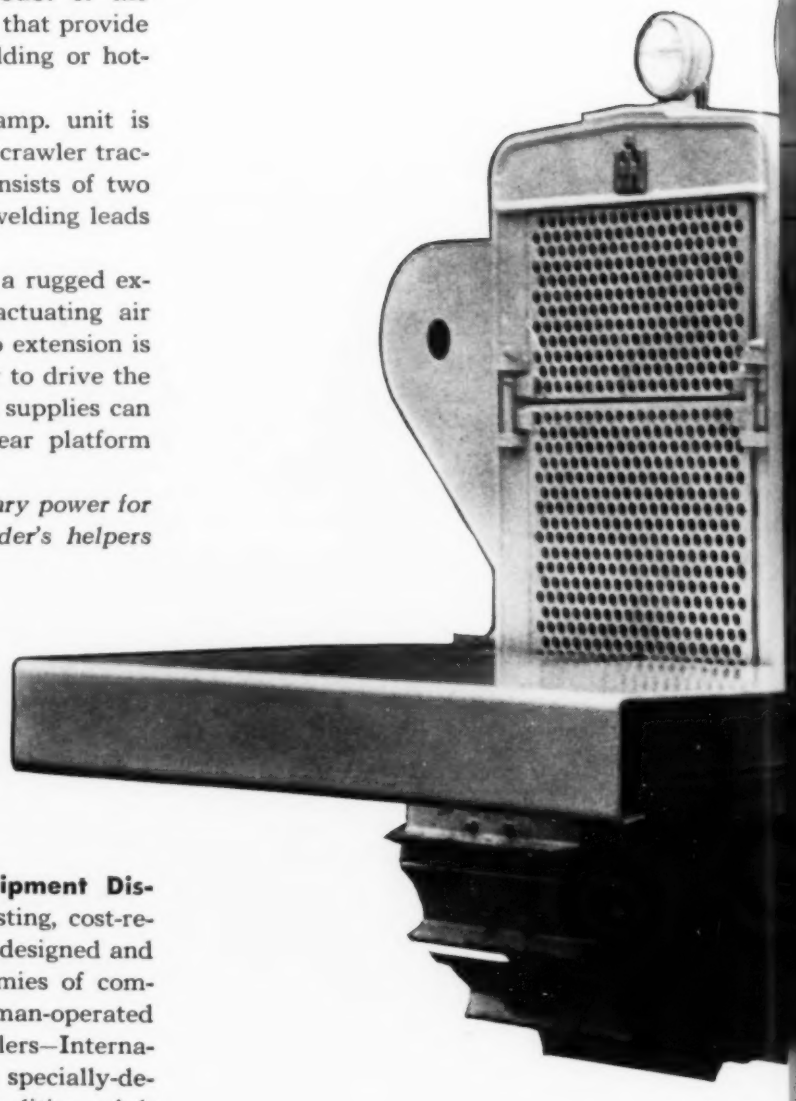
Now, International presents the 1961 model of the TD-15 Pay welder—with major improvements that provide greater efficiency than ever for your tack-welding or hot-pass welding crews.

This factory-engineered, high-output 325-amp. unit is powered and carried by the 6-cylinder TD-15 crawler tractor equipped to produce 120 int. hp. Unit consists of two Lincoln dual welders (4 welders), with four welding leads —V-belt driven from front pto.

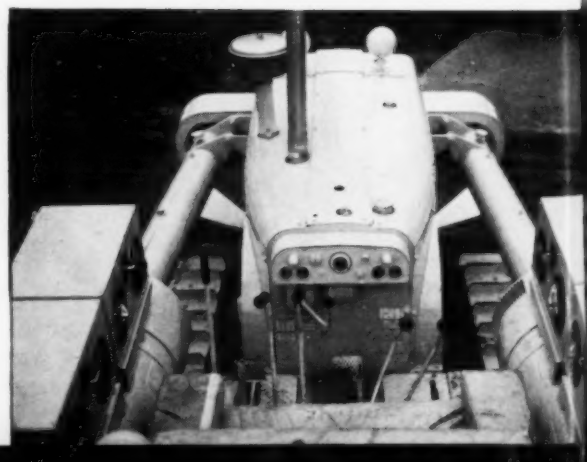
In addition, the new Pay welder gives you a rugged extension platform for mounting your clamp-actuating air compressor. And as standard equipment, a pto extension is provided on which to mount the V-belt pulley to drive the compressor. Even your extra pipe clamps and supplies can be toted by the Pay welder on the large rear platform which is standard equipment!

You save the cost of skid mounts and auxiliary power for welders and compressor. Also, no extra welder's helpers are needed!

Self-contained and self-propelled, this spread-speeding, go-anywhere unit with 74-inch gauge tracks has the ground-hugging stability to operate on all terrain. For maximum flotation on swampy right-of-way, use maximum width (24-inch) track shoes. Positive sealing thoroughly protects vital working parts from dirt and moisture.



See your International Construction Equipment Distributor—see what it means in efficiency-boosting, cost-reducing performance to depend on this factory-designed and engineered welding unit. Measure the economies of combining four welders and compressor in a one-man-operated rig. Compare plus advantages like Dura-Rollers—International's 1,000-hr. lube interval track rollers, specially-developed to meet "eat 'em alive" pipelining conditions. Ask for a TD-15 Pay welder demonstration.



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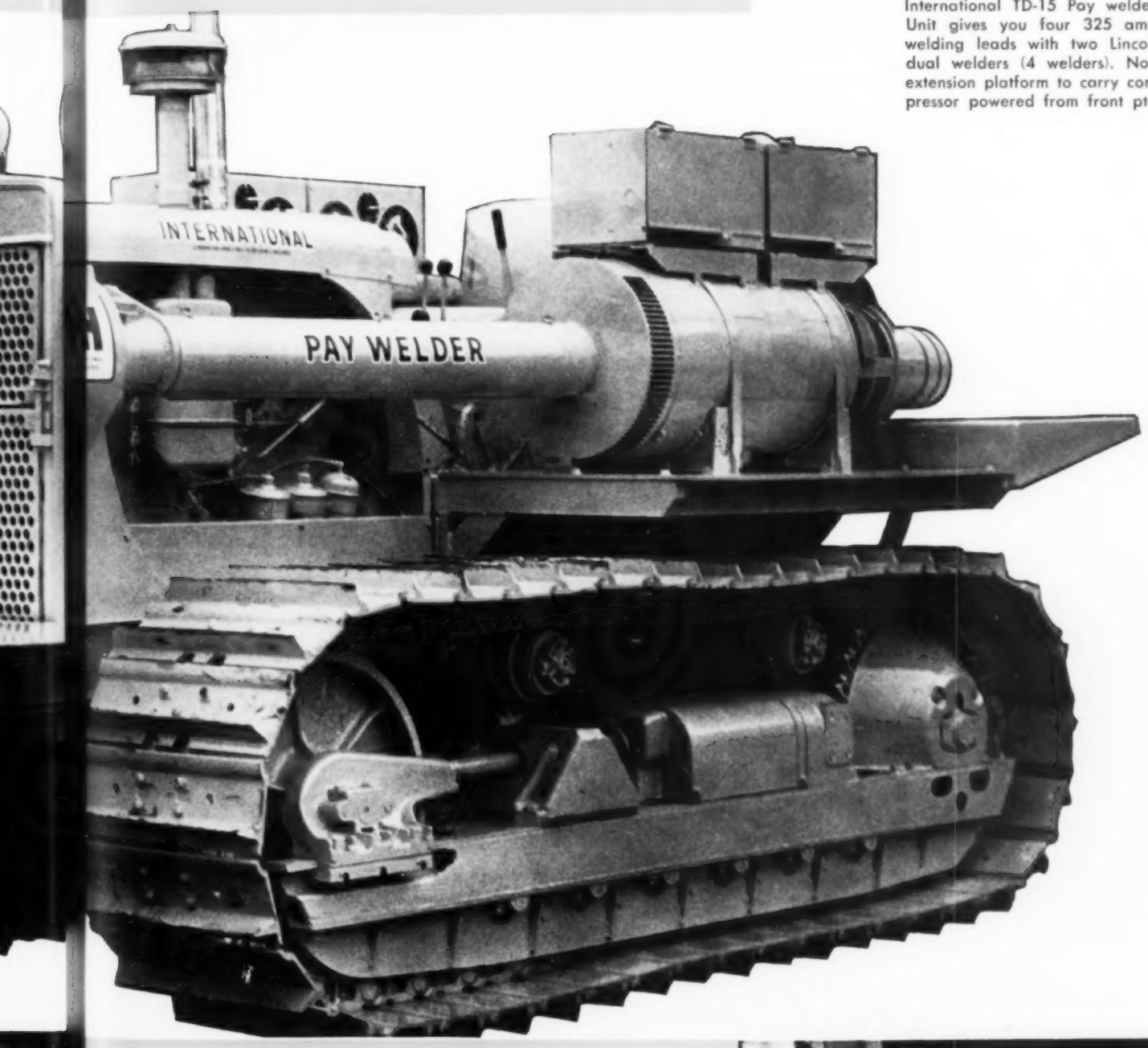
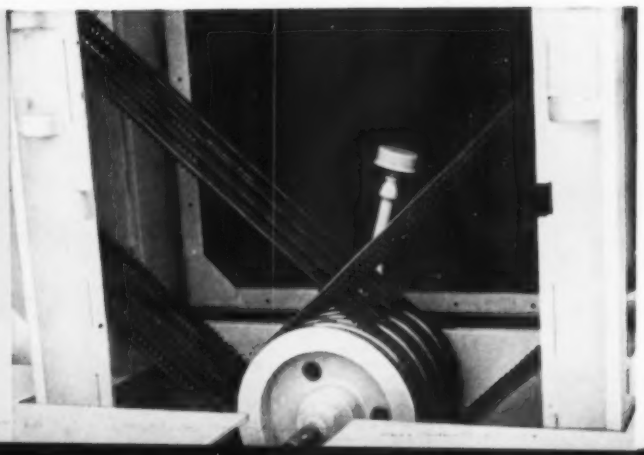
Here's the new completely factory-engineered and built International TD-15 Pay welder. Unit gives you four 325 amp. welding leads with two Lincoln dual welders (4 welders). Note extension platform to carry compressor powered from front pto.



look into the Pay welder erator's compartment—showing the ged, engineered appearance of unit and easy access for the erator. And note the read-easy icator dials, and reach-easy con- ls of the tractor and welder com- nents.

Hinged radiator guard is removed to show pto pulley and V-Belt drives of Pay welder generators. Note pto extension to mount additional pulley to drive compressor mounted on front extension platform. Heavy-duty, sealed, dual-race ball bearings carrying the pulleys provide life-prolonging performance protection in the Pay welder.



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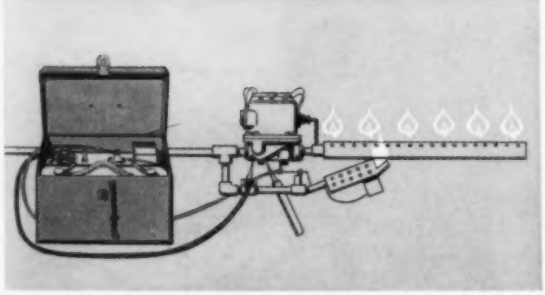

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PIPE LINE PANORAMA

Why Railroaders Are Turning Into Pipeliners . . . According to Bob Thomas, President of Mid-America Pipeline, proposed pipe line rates for LPG from Eunice, New Mexico to McPherson, Kansas are 50 cents per barrel, rail rate is now $1.10. From Pampa, Texas to St. Paul, Minnesota, pipe line rate is 80 cents per barrel, vs. rail's $1.68.

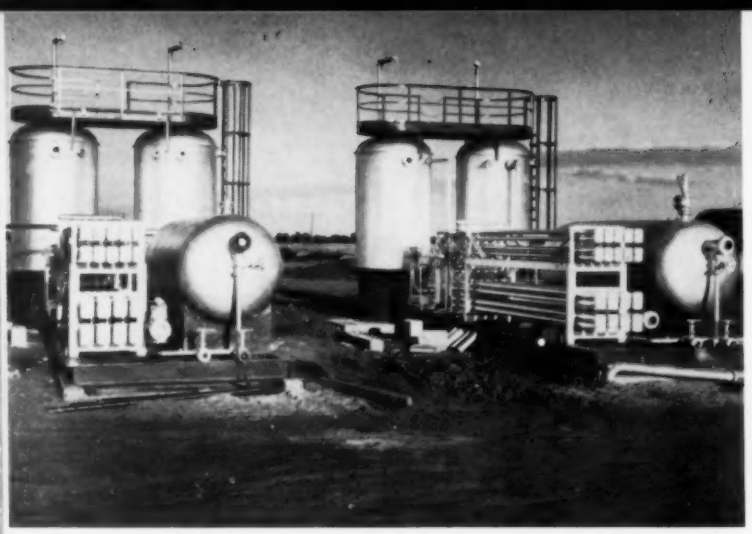
Since they have their own built-in right of ways in many instances, diversifying into the pipe line business is a natural for railroads. Latest entry is Union Pacific which, with Williams Brothers of Tulsa, will build $10 million products line from Colton, California to Las Vegas. At Colton, 225-mile line will connect with Southern Pacific's line which moves products both ways between El Paso, Texas and Los Angeles. Earlier railroaders turned pipeliners include Northern Pacific, Missouri Pacific, Great Northern, and Katy.

Texas-Mexico-California Line Draws Verbal Fire . . . Transwestern Pipe Line President Mills Cox (whose company now serves California with Texas gas through 1,800-mile line) has publicly criticized proposed TGT-Pemex project. Cox says the line is not economically feasible; predicts federal and state green light will not be given. Reasons: Although potential is great, southern California's present gas market (including interruptible industrial load) is not large enough to consume gas capacity now available in existing lines—and if it were, Transwestern could handle needs cheaper than proposed line.

Canada-California Gas Line Underway . . . Contracts have been let and construction is underway on 1,400-mile gas line from Alberta to San Francisco. H. C. Price and Western Pipe Line-J. P. Neill & Company, will build 905-mile, $200 million U.S. portion of line. Section from Alberta border to U.S. will be built by Price-Poole of Canada.

First Canadian Gas to Midwest . . . Midwestern Pipe Line's 560-mile, $52 million gas line from Minnesota-Canada border to Marshfield, Wisconsin started serving upper Midwest consumers in mid-October—two weeks ahead of schedule. Initial capacity: 204 MMcf per day through 504 miles of 24-inch main line and about 55 miles of laterals.

Pipe Line Briefs . . . Tennessee Gas Transmission is asking Fifth Circuit Court of Appeals in New Orleans to review and set aside recent FPC ruling holding company to 6⅛ percent return on new gas sales; TGT wants 7 percent . . . **Meanwhile,** pipe line companies are encouraged by recent FPC trend to allow up to 6.5 percent return on sales, instead of traditional 6 percent . . . **Major breakthroughs in near future will create tremendous new demand for pipe lines,** according to C. C. Whittelsey, president of pipe line consulting firm, Ford, Bacon and Davis; he predicts future lines will not only transport a large variety of solids, but will serve as a long-distance mixing vat, i.e., grains, sugar cane, and wood chips may be partially processed as they pass through the lines . . . **New 485-mile line** will transport 160,000 barrels of crude per day from two new oil fields in southeastern Algerian Sahara to La Skhirra in Tunisia, for the French market; line will be completed next year . . . **Court tests are expected soon on FPC's new area pricing policy for natural gas;** industry observers fear new plan will add confusion to an already confused situation, may delay long-sought legislation to free producers from federal control.



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Construction of new Mid-America system began on April 6; it is scheduled for completion December 1. Corrosion protection of 4 to 10-inch line network used a polyethylene tape on southern sections; from Levelland, Texas north pipe has a coal tar, glass inner and outer wrap protection system. Rates of progress set records on several of seven spreads; one spread made 38,800 feet of 8-inch in one day.

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How New Mid-America LPG Line Will Be Operated

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By Melvin A. Judah, Editor
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LINE FILL IS NOW WELL ALONG as construction operations near completion on Mid-America Pipeline Company's 2,170 mile system from Eunice, N. M., to Minneapolis and to Madison, Wis. Seven construction spreads are setting records; but the system's real newsmakers are its many innovations in control and novel operating plans.

Originator of the idea for the Mid-America system was the M-K-T Railroad who still retains 19 percent of the Mid-America stock; Williams Brothers Company was in on the engineering, design and construction of the system from its conception. Feasibility studies first began in 1957. Many of the new design features are the product of Williams Bros. engineers.

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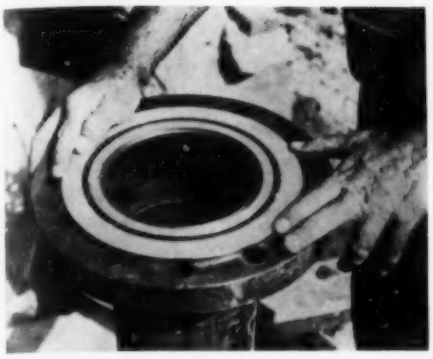

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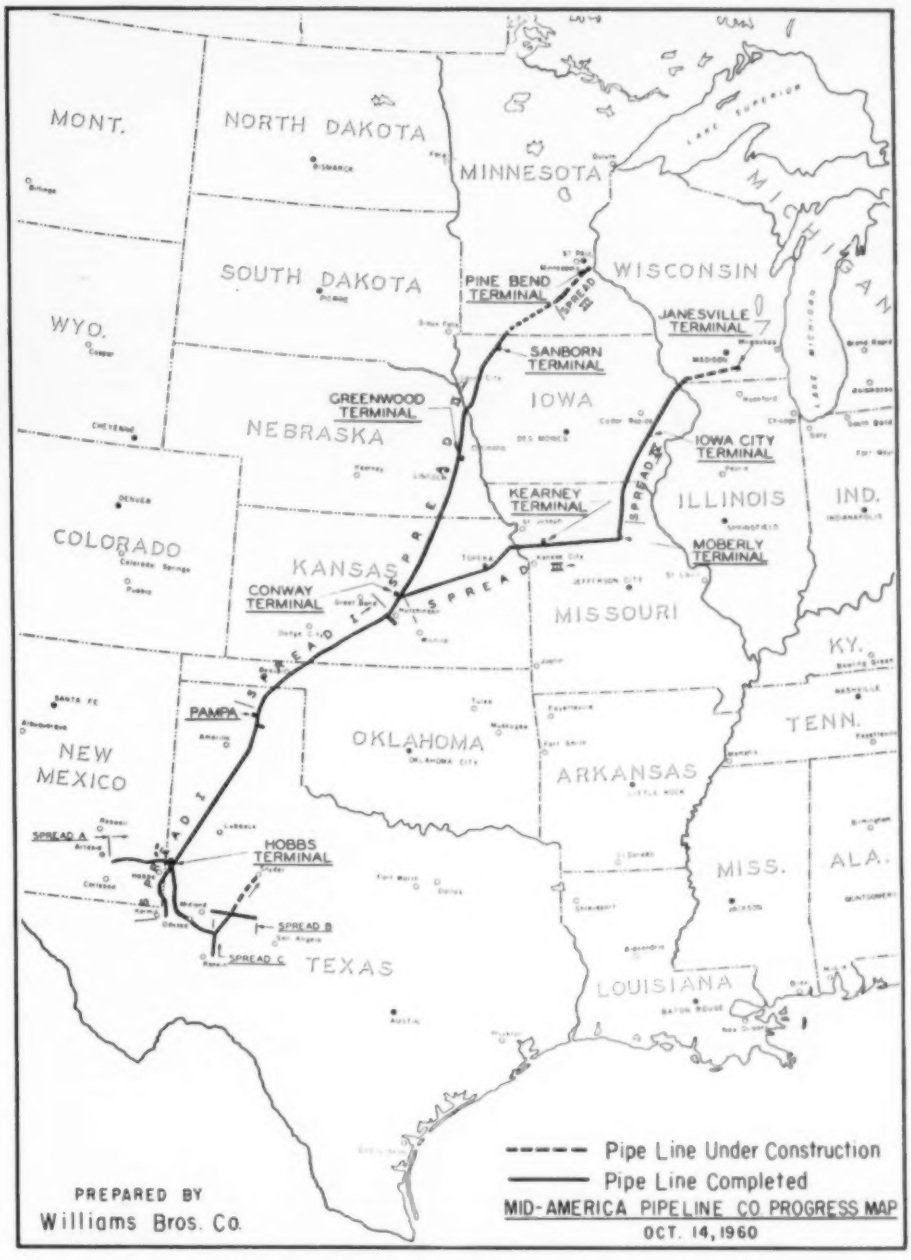

Map of the new Mid-America Pipeline Company system. Operation, receipt of product from storage, and delivery will be automatically controlled by dispatcher from Tulsa. Thirteen pump stations and nine terminals are highly automated.

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As an aid in control, the following supervisory signals are sent back:

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- Power failure.

Pump Station Protection. All of the main line pump stations on the Mid-America system have complete electrical and mechanical monitoring devices. Electrical system protection instruments will detect low 2,300 volt AC supply, reverse phase AC, low station battery power or low instrument supply. Mechanical protection instruments sense low suction pressure, high discharge or pump case pressure, low flow rate and arrival of scrapers.

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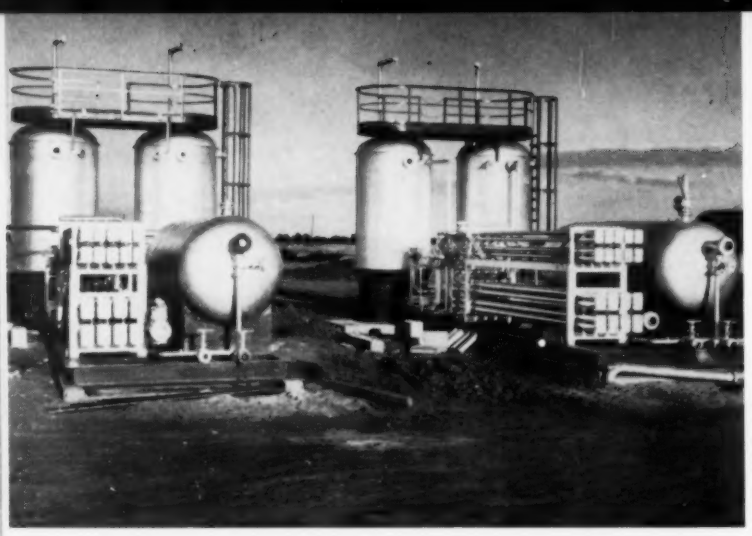
Operational Control of Stations. The station control system for a typical unattended unit includes suction



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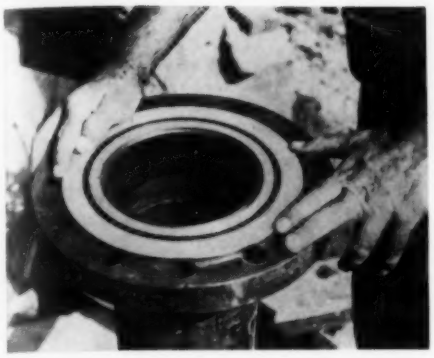

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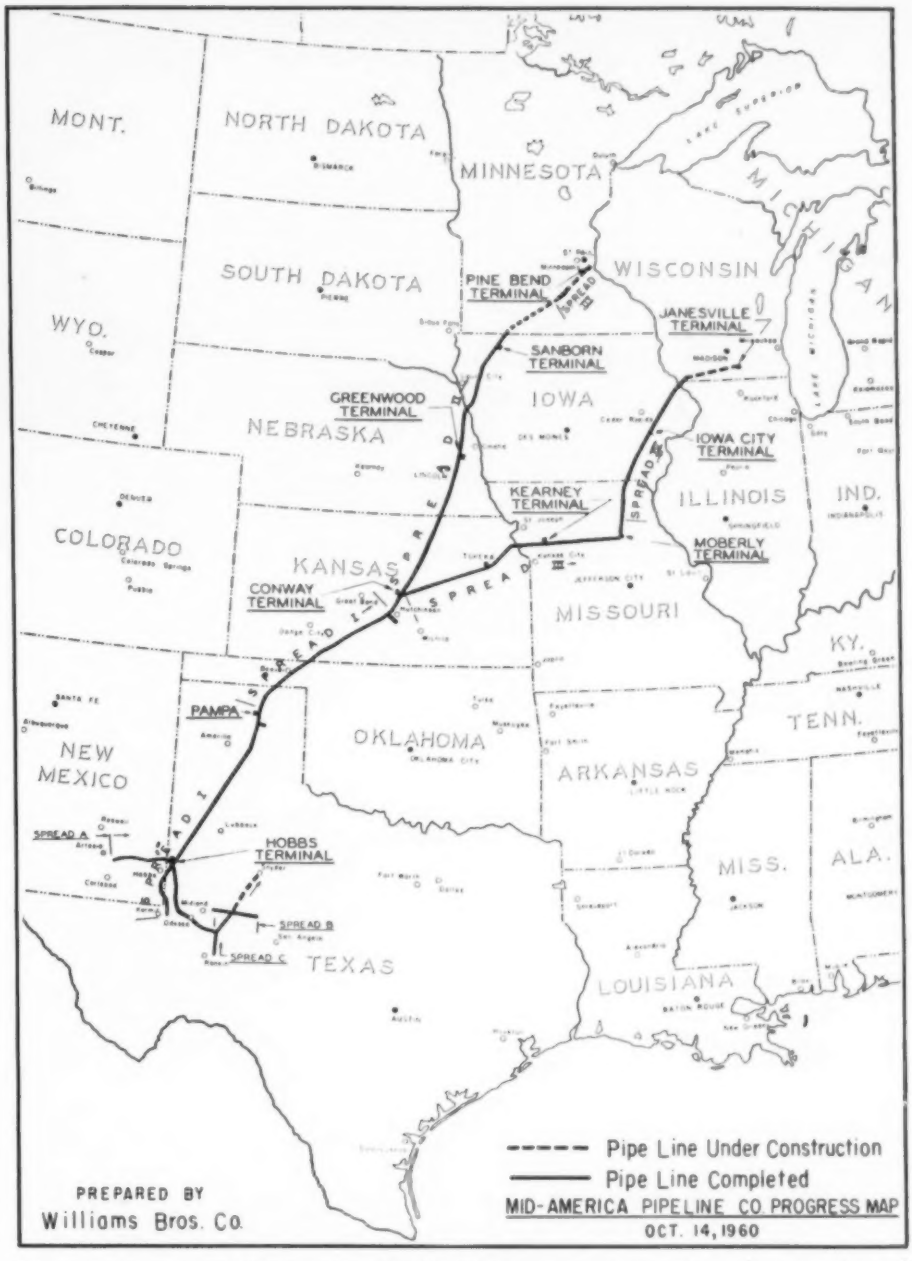

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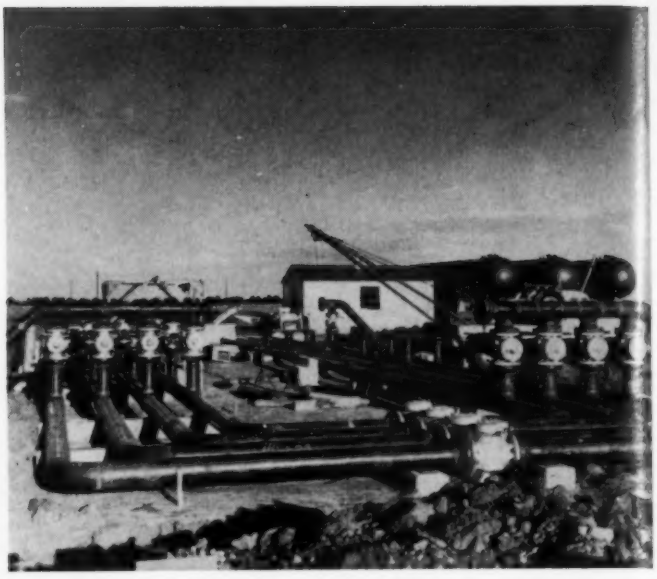
Pump station at Conway, Kansas near McPherson is actually two stations in one. Mid-America's 10-inch line splits here so station operates as "Conway East" or "Conway West". Electric motor drivers and pumps were standardized for future flexibility and to reduce spare parts inventory and maintenance time. Electric motors are fully accessible, weather protected NEMA type I.



Mid-America's terminals provide a variety of LPG transfers. Conway is the most versatile; it is possible here to receive a batch from the 10-inch into either above ground or cavern storage, and at the same time be withdrawing from two other storage units, dehydrate product, and pump out into the two outgoing laterals. Special capacitance type plate probes detect batches and monitor moisture contents of LPG streams.

and discharge pressure transmitters, suction and discharge pressure controllers and an autoselector device which automatically connects the particular pressure controller in a control zone to the control valve. Control of the suction and discharge valves is in standard sequence with the start and stop control of pumps.

Pressure controllers have both proportional and automatic reset control. An anti-reset, wind-up device was incorporated to make suction pressure control response more sensitive. This device keeps a proportional band centered about the set point regardless of the length of time suction pressure is held satisfactorily. If suction pressure begins to fall the suction pressure controller takes corrective action just as soon as the proportional band has been entered.

Two operating set points are provided on the suction pressure controller at each station; these are preset according to suction pressure required for the product being handled. This set point can be remotely switched by the dispatcher from Tulsa.

Miniaturized solid state, electronic components are used on the Mid-America system for pressure and load controls. Load control is used in addition to pressure controls at the Hobbs, Conway West, and Conway East pumping stations. Use of load control on both pump units provides flow control as well as load control at these stations.

Telemetering Functions. Individual digital encoders take off suction, case and discharge pressures at each station; these, together with meter readings, are telemetered to Tulsa. No local recorders are used at stations. Mid-America's telemetering system reports only significant pressure variations from the last telemetered value; it does not give a continual display on the Tulsa control panel. Meter readings are telemetered and displayed on completion of delivery or on demand.

In selecting this system, engineers made maximum use of the communication channels available, and at the same time eliminated unnecessary accumulation of data at the control point.

Mid-America's supervisory control and telemetering equipment utilizes a pulse code transmission over a telegraph grade leased wire channel. In this transmission system, each signal consists of exactly 24 steps in the code. A single message group is composed of a fixed number of long and short periods of time. Each period of time is called a step; intelligence is transmitted over the communications circuit on both the energized and de-energized step by the character of the step link and its position. Each step is a binary decision element or bit equal to a logical "yes" or "no" which may be used to transmit intelligence.

Intelligence Security. A number of checks prevent false operation that might result from communication outage or equipment troubles.

On control functions, the coding system checks total pulse count, parity, address, and unique pattern. For telemetering functions the above are also checked, except for parity, and a noise discrimination check is added. For remote indication, security of the system is checked for total pulse, address and noise discrimination only.

If any control or telemetering transmission does not pass all proper checks, it will be rejected, and the Tulsa dispatcher will be advised by an invalid signal transmission light; the control signal he sent would not be acted upon. On incoming transmissions the signal has to pass security checks before being accepted into the Tulsa equipment.

How the System Will Be Controlled. Mid-America's complete system will be controlled from a push button console at the dispatcher's center in Tulsa. To start an operation, first, the dispatcher will select the button for the station he wants. Then by selecting one of a series of other buttons he can send a control function or demand a read-out of data.

In the transmission of intelligence

on the circuits, control functions receive top priority. Telemetered data is of the lowest priority, and will wait until all control and indication signals are off the line. Incoming data is displayed on a series of panels arranged in a semi-circle around the dispatcher's desk. Each pump station has its own data panel; provisions are made for additions of future stations. All data is displayed in digital form, code wheels provide permanent data storage so that information will not be lost in the event of a power loss to the dispatch board. Controls for the entire system are integrated.

Data Readout. At the Tulsa dispatch center electric typewriters provide a permanent record of incoming data for dispatcher's use and record keeping. One electric typewriter records pressure data, and another, meter readings. The system will automatically check the complete line every hour, interrogating meters at exactly the same time to check out system volumes. Ultimately, this data set-up could provide for automatic billing.

Unattended Deliveries. Plans call for deliveries from the Mid-America system to the distribution terminals to be remotely controlled by the dispatcher in actual operation. In addition, of course, they may be handled locally at Conway or other points by operating personnel. Deliveries and custody transfer will be through turbine or PD meters.

The dispatcher can control product movement to any delivery point on the system. He can open and close all valves needed to handle a delivery or movement of a product to storage. When a delivery is signalled the valve opens on order from the dispatcher; it will close automatically when the volume he has preset has been delivered to the terminal. All the dispatcher needs to do is to set in the quantity desired at the console and send the signal to the delivery point.

When he does, these delivery steps take place at the remote terminal.

- Dispatcher's meter preset code is stored in a bank of relays.
- Meter counter relays are reset to Zero and then read out into data storage.
- New meter reading (after zeroing) is transmitted to Tulsa so the dispatcher knows the meter has been correctly reset.
- Delivery block valve is opened and product delivery begins.
- Signal is sent to dispatcher indicating delivery valve open and start of actual LPG delivery.

During delivery the meter generates a pulse for each ten barrels passed. Pulses are counted by the relay matrix and when the total count is equal to the value in the meter preset relays, delivery is completed by closing the electrically operated valve. After the valve is completely closed, the total delivery volume is telemetered to the dispatch center and presented on the control panel; it is logged out either on the next hourly roll call or on demand.

Reversed Check Valve Safeguards Terminals. Design engineers came up with a novel method of safeguarding against overfilling terminal facilities or bleeding down the main line. A check valve has been placed in the delivery line reversed against normal flow, but the flapper is normally latched open mechanically when control power is on.

In the event of power failure, a pnuematic timer acts to initiate the closing sequence after a ten second delay. If power is not back on at the end of this preset time, an electric solenoid trips the mechanical latch and the flapper shuts off delivery. The check valve must then be reset manually before delivery can be started again. An additional safeguard is provided in the event of a power failure during delivery; at the time normal power is restored the delivery valve returns to the closed position and the meter reading is transmitted to Tulsa to insure exact recording of deliveries.

The "backward check valves" are also used in each incoming line as a safety device to prevent overpressuring yard piping. These valves will also close automatically in case of an emergency shutdown of a terminal, so the main line will have tight line operation regardless of conditions at any operating or delivery terminal.

Metering. Mid-America uses positive displacement meters for custody transfer and receiving products into the system and turbine meters for control of main line and storage volumes. All meters are equipped with electrical pulsing contacts; they may be readout at counters, on the meter or at remote readouts.

Turbine meters installed on lines going into and receiving products from the storage terminals have contacts to operate a remote digital counter on the control panel. This contact provides one pulse for every ten barrels of product. Pulses energize the counting relays in the supervisory control system and total readings are available to the dispatcher as explained previously.

Distribution terminal meters also use a contact system to provide a pulse for every 10 barrels of product passed; in this way the counting relays provide for remote telemetered readouts. Meters on the gathering lines at Hobbs as well as the local delivery meters used at Conway will provide indication of flow rates. To do this each meter is equipped with a 2,000 pulses per barrel generator. This signal is fed into a solid state amplifier which measures the frequency of the input signal and gives a DC output proportional to the frequency of the pulse input. The output of this system thus provides linear indication of flow rate.

Meter proving. After considering all of the problems associated with metering LPG and the proving of meters, Mid-America's designers came to the conclusion that the best type prover would be the portable piston-type using a sphere sweeping out a known volume through a U-shaped pipe system. This prover system is a closed one connected just downstream of the meter using quick coupling swing joint piping with a design working pressure of 1,000 psi.

Capacitance batch detectors. To detect batch interfaces of LPG at Hobbs and Conway terminals, Mid-America utilizes a novel capacitance instrument installed on the upstream scraper traps. The instruments are somewhat different from traditional capacitance devices used for batch interface detection; "probes" are made up of several parallel plates with insulating spacers mounted on a 6-inch blind flange. Plates are installed in the line below the scraper traps in such a way that the plates parallel flow. Recorders and alarms on the ter-

minal panels announce arrival of the interfaces; a continuous record is also kept of this capacitance data.

These same "probes" are used upstream of the LPG dehydrators to prevent saturating the dryer beds; and they are used to detect excess product in the water discharge lines from the underground storage caverns. Both of these water monitoring functions provide an alarm and an automatic shut down of necessary lines to prevent dehydrator flooding or loss of LPG through water disposal lines.

Terminal operations. The 2,170-mile Mid-America system will have two principal operating terminals. One at Hobbs, New Mexico can receive products from three gathering systems, batch them into tenders or hold product in underground cavern storage to smooth out line operation in the 10-inch main trunk system. At the Conway terminal near McPherson, Kansas, Mid-America's 10-inch trunk splits into two 8-inch laterals; the "west" lateral to serve Pine Bend, Minnesota near Minneapolis, the "east" lateral to Janesville, near Madison, Wisconsin. Functions of the two main operating terminals are very similar so their design has many close parallels.

At Conway, it is possible to receive a batch from the incoming main trunk, put it into storage, and at the same time be withdrawing from either above ground or cavern storage for delivery into either one or both of the outgoing laterals. Product from underground caverns may be dried through two dehydrator units thus supplying both of the laterals simultaneously while product is being received into surface storage.

Underground storage is provided at Conway by three 27,000 barrel capacity caverns which were washed out of a salt formation between 605 and 700-foot depths. In operaton, the cavern is completely filled with either liquid LPG or water under pressure at all times. A 600 horsepower, electric-driven centrifugal pump can inject up to 90,000 barrels per day; one 150 horsepower electric motor driven water injection pump is used to recover products from underground storage; maximum recovery capacity from three caverns would be 90,000 barrels per day.

Dehydration. Before product is accepted by Mid-America for pipe line transportation it must be dried to meet specification dryness. Product being recovered from the pipe line company's cavern or other caverns will be dried by one of two dual dehydrators. Dehydrators use activated alumina as a dehydrating agent and each has twin towers with regeneration equipment for continuous operation. Each dehydrator unit can handle 53,000 barrels of LPG daily to meet dewpoint specification of —40° F.

At Conway, six 63,000 gallon tanks are provided for propane storage. These have an ASME code working pressure of 250 psi; an interconnected vapor system provides maximum flexibility during filling and drawing. To increase the filling rate, filling is from the top through a spray header. A 75 horsepower vertical, can-type pump is used for pumping out of the above ground tanks and for boosting suction to main line pumps.

Delivery terminals. Mid-America's system will have seven distribution terminals for truck loading with six of these having rail loading facilities also. Here again the idea of standardization and use of a uniform, proven design stands out. Only where absolutely essential are there differences in design features of the various terminals. Deliveries to all of the distribution terminals are initiated by remote control from the Tulsa dispatch center. Quantities to be delivered are transmitted and preset into local equipment. Meter readings are automatically transmitted to the dispatcher, then reset, and motor operated terminal valves are opened to initiate delivery. After the desired quantity has passed through the meter, the terminal receiving valve is shut off, and the quantity delivered is transmitted digitally to Tulsa.

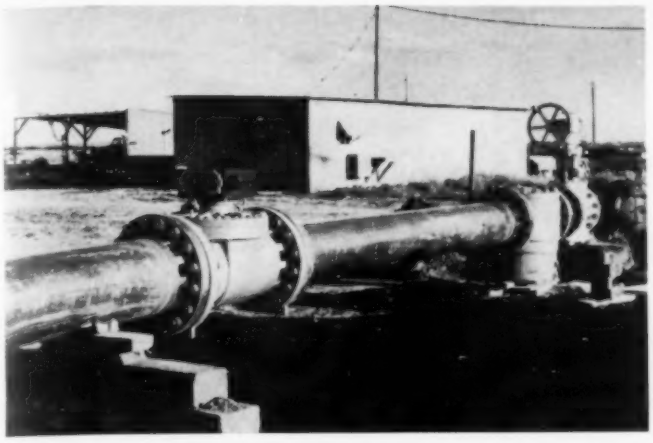
The Greenwood, Nebraska terminal serving the Omaha area, and the Kearney terminal serving the Kansas City area each have two 63,000 gallon propane storage tanks with a design working pressure of 200 psig, a two truck dock and five position tank car rack. The Moberly, Missouri terminal is identical except it has no tank car loading facilities. Terminals at Sanborn and Iowa City, Iowa have three 63,000 gallon tanks, a two position truck dock plus ten spot tank car racks. The final terminals at Janesville and Pine Bend each have five 63,000 gallon storage tanks plus two position truck docks and one ten car rack each.

Although LPG has to meet dryness specifications before being pumped into the line by Mid-America, dehydrators are also provided at each distribution terminal. These are calcium chloride, cartridge type also equipped with filters; they are rated at 500 gpm and 500 psig.

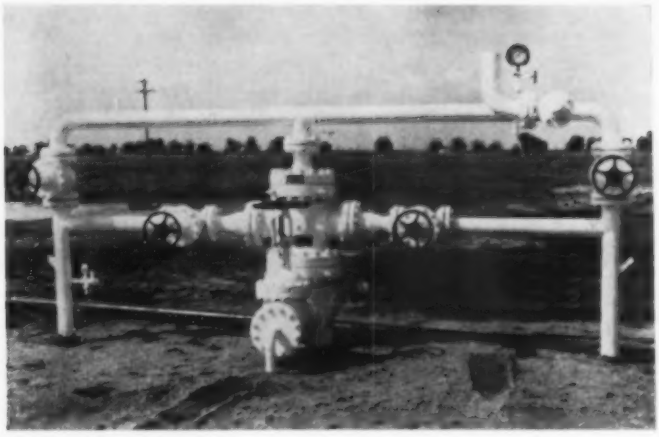
Odorant is injected into propane at

Strainer in PD meter installation at Skellytown, Texas station; 580 barrel hour PD meter can be seen in background. Receipt of product and delivery of LPG to customers are on PD metered volumes. All meters will be proved by means of a portable piston type prover utilizing a sphere and counter system that permits continuous "sweeping" of a known pipe displacement volume of LPG under high pressures, on-stream.

Mainline pumping unit at Mid-America's Skellytown station near Pampa, Texas. Design provides for future expansion in capacity by replacing stages in pumps or changing impellers as well as by addition of stations. One single pump rotating element will serve as a spare for 14 main line units.



Turbine meters are used for control of line volumes and transfer of products into and out of Mid-America's cavern storage. Readout of meters can be from counters atop the meters or by telemetering on remote control panels.



Conway storage terminal of Mid-America has three 27,000-barrel capacity caverns washed from salt formation at 60 to 700-foot depths. Using a 600 horsepower electric motor driven centrifugal pump, maximum injection rate is 90,000 barrels per day into the three caverns.

the truck and tank loading positions. Delivery to trucks and tank cars is by PD meters. Meters are proven by an oscillating piston-type meter prover.

Communications. Four teletype grade circuits connect the Tulsa control center with all control points on the Mid-America system. One circuit controls the Conway terminal and stations in that area. Another channel controls line functions from the Beaver, Oklahoma station southward. Other channels control functions from Greenwood, Nebraska north on the west lateral and from Kearney, Missouri east on the Janesville lateral. These teletype circuits are used for supervisory control and telemetering. Communications to Hobbs and Conway are via teletype from Tulsa. VHF voice channels link stations and mobile units from Hobbs and other operating centers north to Conway. From Conway north mobile VHF facilities are provided only between cars.

Pump stations. Thirteen pump stations are used on the Mid-America LPG system. Several features stand out in the design of the stations. First, standardization of parts and design minimizes spare parts inventory and maintenance. Only four different sizes of pumps were selected from two manufacturers; one type and size of mechanical seal is used at all stations. Electric motor frame sizes were standardized with one size frame used for the 600, 700 and 1,000 horsepower drivers; and a single pump rotating element can be used as a spare for 14 of the main pipe line pump units. This design approach will provide for future expansion by replacing stages from existing pumps, changing out impellers, adding stations or by various combinations of these approaches.

Main line pump drivers are 2,300 volt squirrel cage induction motors in NEMA 1 weather proof enclosures. Pump drivers range in horsepower from 350 to 1,000 horsepower.

Novel gaskets. To solve one of the problems that often may cause serious problems in handling LPG, Williams Bros. selected a new type metal, synthetic rubber "O" ring gasket. Not all flange connections could be eliminated in design, so the new gasket will be of particular valve in future maintenance or station modification.

This gasket is made of a metal ring having synthetic rubber "O" rings on each side. It provides metal-to-metal surface contact between the flange and gasket and "O" ring seal on both sides. In tests by Williams Bros. on a 6-inch, 600 ASA flange under hydrostatic tests, the seal developed a slight leak at 5,950 psig. Upon lowering the pressure to 4,000 psig and increasing back up to 4,800 psig, the seal returned to a bubble tight shut off; and this test was carried out on a flange that had a scratch across the serrated face. Test of the new gaskets indicate that they will certainly hold well over the 1,440 maximum pipe line operating pressure. In addition, these gaskets saved make-up time and are reusable.

Main line design. Mid-America's main line was constructed by seven spreads. Actual construction work by Williams Bros. commenced on April 6; completion of the entire system is scheduled for December 1. Four Williams Bros. spreads plus three McVean and Barlow spreads handled construction of the entire system.

The Mid-America system is made up of 289 miles of 10 ¾-inch, 0.250 wall API X-52 pipe; 1,240 miles of 8 ⅝-inch OD by 0.219-inch wall X-52; 154 miles of 6 ⅝-inch, 0.188-inch wall X-46 pipe plus smaller gathering lines. The entire main line system will have a working pressure of 1,440 psi. River crossings are of heavy wall API 5L Grade B pipe.

The corrosion protection system was of a polyethylene tape on southern sections; hot applied coal tar enamel with glass outer wrap was applied over the ditch on the sections north of the Levelland, Texas pump station. The entire main line system is to be hydrostatically tested to a minimum pressure 1,540 psi and will be protected with a cathodic protection installation.

Main line block valves have been located above ground at about 25-mile intervals between pump stations. These are weld-in, through conduit gate valves specified for handling propane.

ACKNOWLEDGMENT

PIPE LINE INDUSTRY wants to thank especially Robert E. Thomas, president; David A. Roach, vice president, G. V. Rohleder, general superintendent, and John Bayne, senior pipe line engineer of Mid-America Pipeline Company; John H. Williams, president and Vincent E. Butler, vice president Williams Bros. Company; A. K. Barlow, president McVean and Barlow; William Haley, manager Southwest District Union Switch & Signal and other engineering and operating personnel of Mid-America and Williams Bros. for assistance on the visit to Mid-America facilities and in the preparation of this article.

Dual-Beam Microwave System Averages Less Than 2½ Hours Outage Per Year

By G. V. Morck, Assistant Superintendent, Communications Department, Sinclair Pipe Line Co., Marion, Ohio

WE CAN no longer afford to be satisfied with a microwave system which performs only 95, 98, 99 or even 99.5 percent of the time. With the increasing growth of automation in the pipe line industry where remotely controlled pumping stations are becoming commonplace, outage time for private communication systems is taking on a new significance. We must constantly strive for the ultimate goal of 100 percent reliability by taking advantage of the latest technological advances made in the electronic industry.

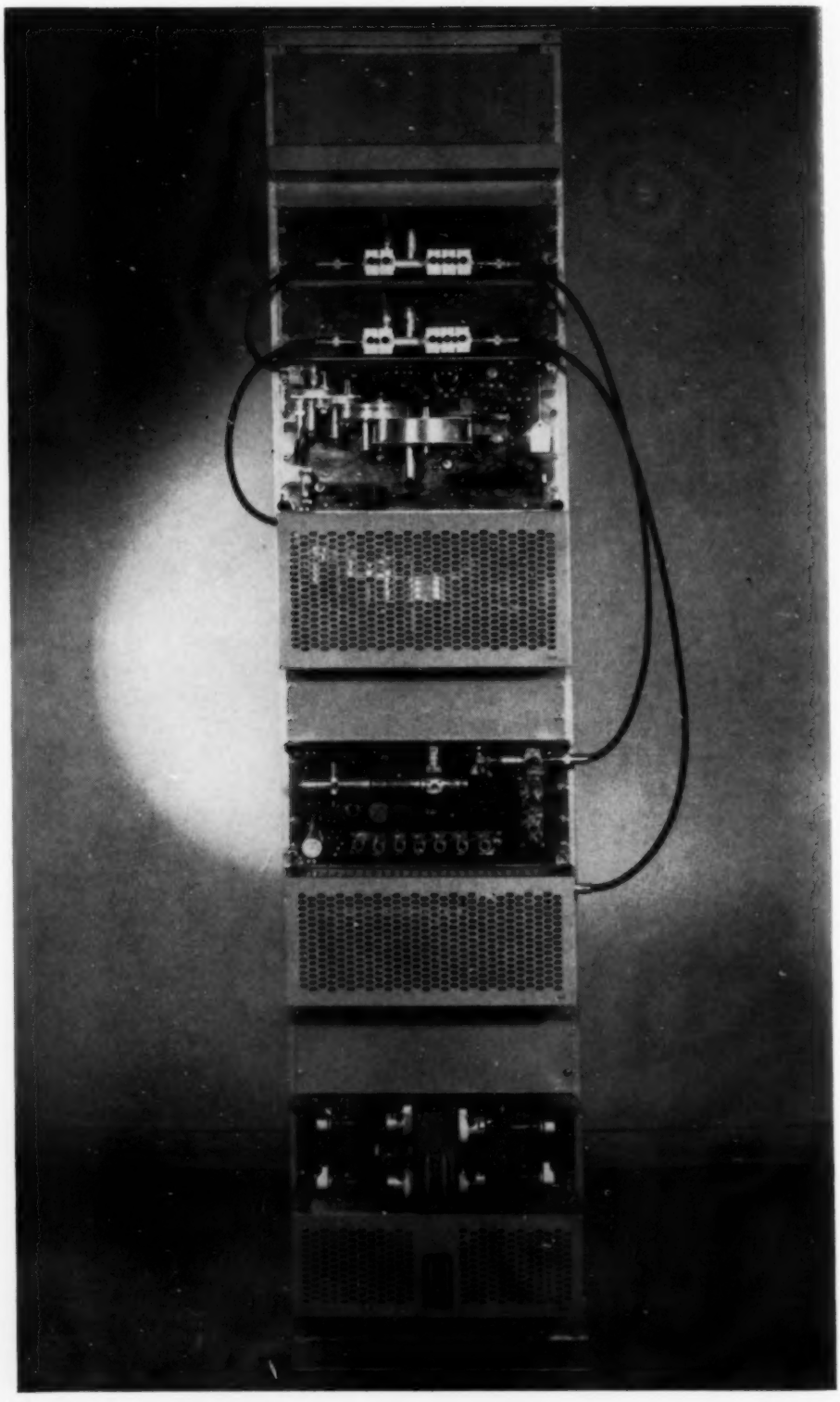
One such advance is the *dual-beam microwave* system. This system has been employed by the Sinclair Pipe Line Company since September of 1956. Since that time, we have obtained an average reliability factor of 99.973 percent with regards to the R.F. Equipment. **Converted to actual time this amounts to an average of two hours and 20 minutes outage per year! This excellent reliability factor for our R.F. equipment can only be attributed to the use of dual-beam equipment.**

Actually, what is a *dual-beam microwave* system? It simply is a microwave system, that for all practical purposes, is two separate and independent microwave systems operating on a single microwave frequency.

The basic principle upon which the entire design and development of this system revolves around is the ability to separate the vertical and horizontal polarized radio waves of a single microwave frequency.

On the Sinclair dual-beam microwave system, which extends from Pittsburgh, Pa. to Marion, Ohio, there are actually two prime R.F. paths in each direction. These two paths may be classified as:

1. The vertical polarized R.F. Path.



DUAL-BEAM EQUIPMENT showing two R.F. transmitters, two receivers, two duplexers and two power supplies. This equipment has logged a reliability factor of 99.973 percent since 1956. This is less than 2½ hours outage per year!

2. The horizontal polarized R.F. path.

Each R.F. path is independent of the other, electrically speaking. There are separate R.F. transmitters, R.F. receivers, R.F. power supplies, duplexers, and coaxial transmission lines. However, a single parabolic reflector incorporating a dual polarization horn feed is used for the simultaneous transmission of both polarized radio waves.

The basic microwave equipment which is utilized in this system operates in the 2000 Mc band. The video output signal from the multiplex equipment at the terminal station is applied simultaneously, by means of a parallel feed hookup, to two transmitters.

In a dual-beam operation of this type, it is mandatory that the R.F. outputs of both transmitters be at exactly the same frequency so a method of synchronizing both transmitter's oscillators must be provided.

The R.F. outputs of both transmitters are fed through separate duplexers and via separate coaxial transmission lines to the two polarization inputs of the center-fed horn driven parabolic reflector. The radiated energy of the parabolic reflector now contains a vertical and horizontal polarized wave with each wave operating on the same frequency.

At the receiving station the polarized waves are kept separated by means of the special antenna and individual coaxial lines until the R.F. signals appear into the R.F. receiver. The video output of the two R.F. receivers are electrically tied together and feed a common load such as the receiving multiplex equipment or, in the case of a true back-bone repeater station, the input section of the two R.F. transmitters. From this point the process is repeated once again.

Full duplex operation is used on each polarization, as in a conventional microwave system, with a frequency separation of 70 Mc between the transmitting and receiving frequencies.

Each microwave repeater station thereby contains the following R.F. equipment:

Two transmitters for the east-west direction. (One for the horizontal polarized wave and one for the vertical polarized wave.)

Two receivers for the east-west direction. (One for the horizontal polarized wave and one for the vertical polarized wave.)

Because the west-east direction contains the same number and type of R.F. equipment, the total number of transmitters and receivers will equal four of each. Of course at a terminus station the number of units will be one-half of the above amount.

Monitory and alarm features are provided in each individual transmitter and receiver which will automatically disable the unit from the system in case of trouble and transmit the proper alarm code to the terminal station. This prevents a faulty unit from introducing noise into the system.

An added feature is that the AGC busses of each pair of receivers are interconnected. This assures parallel operation of the two R.F. receivers over a range of moderate differences in received signal strength, while forcing *cut-out* or disabling, of the receiver with the poorer signal strength under conditions of large disparities of signal.

A bonus feature inherent in a dual-beam microwave system is an increase in signal-to-noise ratio of up to 3 db—as compared with a conventional single path system. Explanation is that the intelligence signal portions of the two radio waves will add algebraically by being synchronous, while the noise components from the receivers will add on a power basis. Therefore, with this parallel operation, the total combined signal output will be six db greater while the combined noise components will only be three db greater.

Operating and maintaining a dual-beam system. What are the advantages of a dual-beam system from the operations and maintenance standpoint? As compared with conventional microwave equipment utilizing 50 or 100 percent standby equipment there are a number of advantages. Here are some of the most important ones:

1. No standby equipment is necessary. The dual-beam microwave system has no standby equipment if one considers the word *standby* in accepted terms. All the equipment on the system, if operating normally, is performing a work load and is contributing equally to the successfull operation of the system. Thus there is no need for complex switchover units with their associated sensing equipment, no interruption of traffic should a transmitter or receiver fail, all units are constantly monitored for abnormal operating conditions, and perhaps the greatest advantage of all is that the microwave maintainer can readily observe, check and analyze a defective unit under actual operating conditions and initiate repairs without interrupting traffic.

2. No switchover panels are necessary with a dual-beam system. Conventional standby equipment necessarily depends on switchover and sensing equipment which at times is almost as large and complex as the equipment being switched.

Too, there is the possibility that the switchover unit will not function properly: either failing to switch the standby equipment into service when called for, or switching the standby unit into service when not called for. At any rate, malfunctioning of the switchover unit is a cause for increased outage time. This problem is non-existent with the dual-beam system.

3. A time lag is always involved when switching over to cold standby equipment. This can be of major annoyance especially on a relatively long system heavily loaded with telemetering information. Even with so-called hot-standby, information can be lost while switchover occurs. This problem is non-existent with the dual-beam system.

4. Reliability of standby equipment. Regardless of the type of preventive maintenance program employed to protect against failures of standby equipment, there is still the possibility that it will fail when it is switched into service. In a microwave station operating with conventional cold standby equipment, there arises the chance that a particular tube or circuitry condition existing within the standby unit is of a borderline condition prior to switchover. The electrical shock that comes with the switchover may drive the borderline condition into a complete failure. With "hot-standby" equipment, tubes and component failures within the standby equipment can (and usually do) occur between the visits of the maintenance man. When this happens standby protection is lost at the station until noticed and corrected by the maintenance man during his next visit. Our position regarding standby equipment is that its sole function

Continued on Page 50

A Thin-Route, Beyond-The-Horizon VHF System Controls Middle East Stations

Thanks to antenna array design 250 watt transmitters are adequate for the 120 mile links. The 160 mc system carries four voice channels. (three derived and one physical) and three tone channels

By J. D. Hoffman
Assistant Chief Engineer
(Communications),
Trans-Arabian Pipe Line
Company, Beirut, Lebanon

BY APPLYING A THIN-ROUTE technique in an economical integrated, small-scale VHF system in the 156-174 mc band, Trans-Arabian Pipe Line Company was able to achieve point-to-point multi-channel voice, teletype and mobile communications between the main office in Beirut, Lebanon and pumping stations and mobile units along the route of the line through Lebanon, Syria, Jordan and Saudi Arabia. In addition, the system is providing supervisory control for 5,000 hp remotely controlled pumping stations.

The terminals of a number of the links in the system are well beyond the horizon, ranging from 58 to 120 miles. Towers are 200 feet tall, and duplexed on them are several 250-watt transmitters and dual diversity receivers. Two remote, unattended relay stations are employed in the system.

Background. The 30-inch, 31-inch crude oil pipe line crosses the northern parts of Saudi Arabia and Jordan and the southern parts of Syria and Lebanon as shown on the map. Oil is stored at the terminal near Sidon, Lebanon; from there it is loaded onto tankers.

When the pipe line was built, the company installed an HF communications system which supplied all communications, point-to-point and mobile, along the pipe line until recently. During 1957 and 1958, 5,000 hp remote controlled pumping stations, Figure 2, were added at four locations along the line at distances of 58 to 100 miles from the controlling station.[1]

VHF 160 mc systems were used to carry the remote control and telemetering functions and to supply reliable mobile communication. In the western sector of the pipe line, Figure 3, between Turaif pump station in Saudi Arabia and the Tapline terminal and main office in Lebanon, a relayed backbone system was installed. This provides remote control and telemetering functions, teletype and multi-channel voice facilities. It also provides complete mobile coverage in the 235-mile span between attended locations.

Thin-Route System Design. A thin-route system consisting of a physical channel, three derived channels and several tone channels was the design objective. The physical channel is used as an oil dispatching and mobile relaying channel. The derived channels are used for general purpose communication between the main office of the company in Beirut and the Arabian Headquarters at Turaif. The tone channels are used for remote control, telemetering and teletype. The teletype is a recent addition and is used for general message service. No data has been accumulated on error rate. Performance has been satisfactory. One of the functions carried by the system, surge protection trip, is especially critical as regards reliability. More about this later.

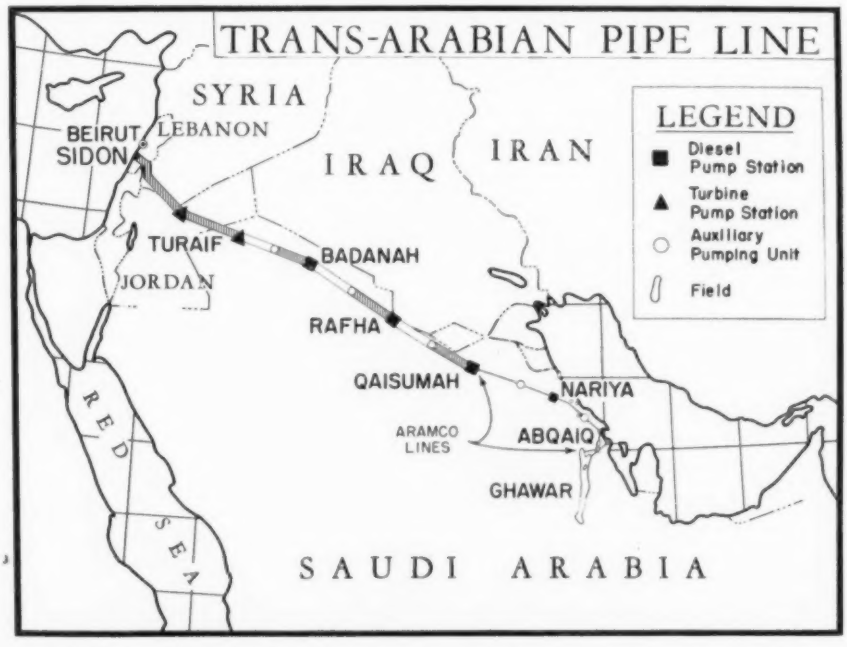


FIGURE 1—Route of the pipe line. VHF links are presently installed in the cross-hatched sections.

FIGURE 2—Remote controlled gas turbine pump station at Uwaigilah, Saudi Arabia. The turbine is fueled with crude from the pipe line. This station and three similar ones are controlled from distances ranging from 58 to 100 miles from the "mother" station. The tower is 200 feet high.

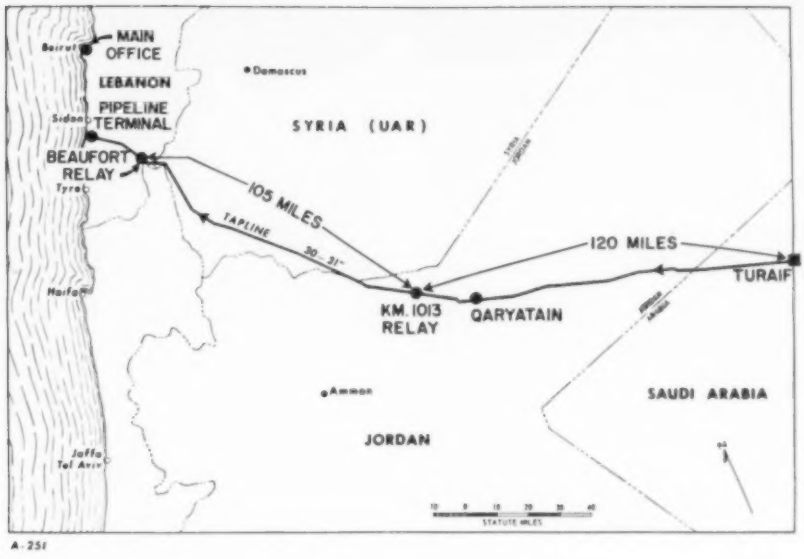


FIGURE 3—Map of the western section of the pipe line. Most of the discussion is concerned with this section. The three remote control links in the eastern sector of the pipe line are of similar design.

The major elements of the design are the following:

1. **Acceptance of relatively low median voice channel to noise and crosstalk ratios.** This takes account of the inherently noisy industrial environment and a degree of conditioning of the users of the system through previous use of noisy, interference-ridden HF circuits. Median channel S/N ratios of 30 db (test tone to noise) during the worst 1 percent of the hours are acceptable.
2. **Use of frequency diversity in preference to space diversity to avoid duplicating expensive towers and antenna arrays.** The second transmitter required for frequency diversity is necessary in any case to achieve the desirable "hot-standby" mode of operation. The additional frequencies required are readily available in the area of the pipe line.
3. **Use of relatively simple low-cost 160 mc radio equipment.** This is possible only in areas where these frequencies may be assigned for point-to-point use as well as for mobile use.
4. **Use of a single large antenna array for each direction along the pipe line, Figure 4.** Each array has duplexed on it the two 250 watt transmitters and two receivers of the point-to-point system as well as the 250 watt mobile system transmitter and the mobile relay system receiver. Figure 5 shows the assembly of cavity filters which perform the duplexing function of Kilometer 1013 relay station.
5. **Use of standard equipment available for quick delivery.** With the exception of the towers and antenna arrays, standard stock items of equipment of several American and European manufacturers were utilized. A small number of field modifications were made. Minor items such as the simplified diversity combiner, transistorized speech clipper-filter unit, transistorized calling amplifiers, and rack wiring harnesses were fabricated in the field.
6. **Use of compandors on the voice channels.**

Choice of Station Sites. In Saudi Arabia, sites were predetermined by the existing main pumping stations and the prepared locations for the remotely controlled auxiliary pumping units. The terrain along the line is flat so that the horizon vertical angles are near zero degrees.

The site for the relay station at KM 1013 in Jordan is on the pipe line right-of-way. It has a good view toward both adjacent stations, and is convenient to a good all-weather road. It would have been desirable to locate this relay station at Qaryatain pump station, 20 miles away. However, the path to Lebanon from Qaryatain is obstructed by a hill which elevates the horizon by 1.5°. This causes an additional 15-20 db loss which makes the path impractical for this type of system.

Beaufort Relay Station in Lebanon is located near the edge of a cliff 500 ft. above nearby average terrain and a half mile off the pipe line. It has a good view toward KM 1013. It is near a public road so that only a few hundred yards of access road was needed. It is free of snow in the wintertime.

System Parameters. Table 1 summarizes the characteristics of the system between the Beirut office and Turaif pump station. Figure 6 is a block diagram of the western sector of the system.

Table 1—Point-To-Point System

1. **Modulation**—FM, with 15 us pre-emphasis
2. **Transmitter Power**—250 watts for long links, 60 watts for short links
3. **Receiver Bandwidth**—85 kc for long links, 170 kc for short links
4. **Receiver Noise Figure**—5 db
5. **Number of Links**—Four on main line and one spur
6. **Distance of Links**—29, 15, 105 and 120 miles on main line and 20 miles for spur link
7. **Number of Voice Channels**—four, three derived and the physical
8. **Number of Tone Channels**—Two 2-way and one 1-way
9. **Speech Clipping—Physical Channel**—10 db

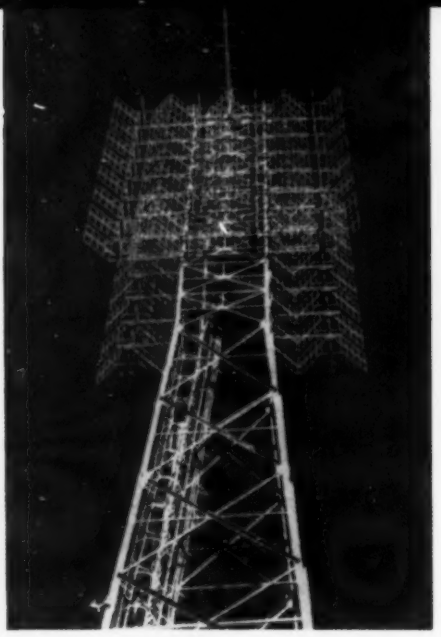


FIGURE 4—Corner reflector antenna arrays at Turaif pump station. Duplexed on this array are two 250 watt transmitters and two receivers of the point-to-point system. Also there is a 250 watt mobile system transmitter and relay receiver.

FIGURE 5—Assembly of cavity filters which perform duplexing function at KM 1013 Relay Station.

10. **Maximum Deviation**— ± 25 kc
11. **Baseband Utilized**—500-15,000 cycles
12. **Freq. Resp. In Carrier Range**— ± 1½ db
13. **Antenna Gain**—22 db, corner reflector array
14. **Design Propagation Reliability**—99.9% overall
15. **Frequency Spacing For Diversity**—4-17 mc
16. **Channel S/N (Test Tone/Noise**—40 db
17. **Channel Signal/Crosstalk**—40 db
18. **Assumed Compandor-Improvement**—22 db
19. **Channel Nominal Level**—20 db below ± 25 kc Deviation
20. **Tone Channel Level**—26 db below ± 25 kc Deviation

Propagation Loss Calculation. The distances involved in the various links are 15 to 120 miles. The shorter links will not be discussed.

Referring to some of the published long-term VHF propagation data,[2, 3 and 4] year-round median basic transmission losses for the longer links are estimated as shown in Table 2.

Table 2

Link	Distance (Miles)	Loss (db)
Jalamid-Badanah	58	154
Uwaigilah-Rafha	90	168
Shubah-Qaisumah	90	168
KM 1013-Beaufort	105	171
Turaif-KM 1013	120	176

The first three links listed are the remote control links in Arabia. It was found that 60 watt transmitters and a large array at only one of the two terminals was adequate for the 58-mile link. The other terminal uses a single large 10 db corner reflector. All the other links listed in Table 2 use the large array as show in Figure 4 and 250 watt transmitters.

Reliability Calculation. The total system gain available in terms of decibel above receiver threshold is as follows:

Transmitter Power	24 dbw
Antenna Gain (over isotropic)	48 db
Receiver Threshold	—139 dbw
Total	211db

Losses for the 120-mile link are:

Long-term median Propagation Loss	176 db
Duplexing & Transmission Line Losses	6 db
Total	182 db

The fading margin is thus 211 — 182 = 29 db. Allowing 16 db for long-term seasonal fading, 13 db is available for short term Rayleigh-type fading during the most unfavorable 1 percent of the hours. Assuming that the diversity combiner performance is intermediate between ratio squared combining and switch type dual diversity, this provides a reliability for the 120-mile link of 99.9 percent. Observation of this link for nine months and a number of signal recordings during afternoon hours indicate that something close to this performance is being achieved. The lowest short-term median signals observed have been approximately 4 uv at the receiver inputs. This corresponds to a path loss of 198 db. The lowest signals almost always occur in the middle or late afternoon. During summer nights free space signal levels (twenty millivolts) are occasionally approached.

An automatic bandwidth restriction[5] addition to the receivers is being tested. This will provide an additional 6 db of system gain in the form of a lower receiver threshold during the deepest fades. This will increase the reliability of the longer links to greater than 99.99 percent at the cost of a small amount of level variation in the carrier channels during the deepest fades.

A study of noise level—cosmic, terrestrial thermal noise—and antenna-to-receiver loss noise indicates that a 2-3 db overall noise figure (antenna temperature 45°C) would be attainable 75 percent of the time using parametric amplifiers as pre-amplifiers before the receivers. The peak cosmic noise figure during the remaining 25 percent of the time is 7 db for antennas facing 290°-319° and 5 db for antennas facing 107°-139°. Parametric amplifiers are being built for trial use on one of the longer links. If their application to the system proves successful, another 2-3 db gain in performance will be available.

The current 5-db noise figure was obtained by substituting the E88CC dual triode in a cascade circuit for the original grounded grid 6AN4.

Diversity Arrangements. As shown in Table 1, frequency spacing of from 4 to 17 megacycles were used to provide frequency diversity operation. Frequency spacings as small as one megacycle have provided good diversity action on test circuits in Arabia. Although no quantitative information has been gathered, the degree of improvement in circuit performance indicates that substantially the full diversity advantage is being realized.

A simplified baseband diversity combiner of the common-cathode type described by Mack[6] is used. Three E88CC 10,000 hour tubes are employed. The contribution to output from each receiver is controlled by the signal level directly rather than by the S/N ratio. The form of the actual transfer function has not been deter-

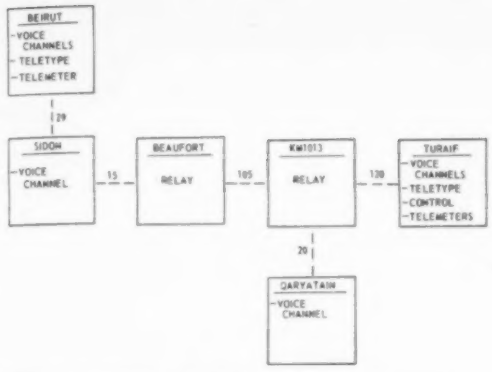


FIGURE 6—Block diagram of the western sector.

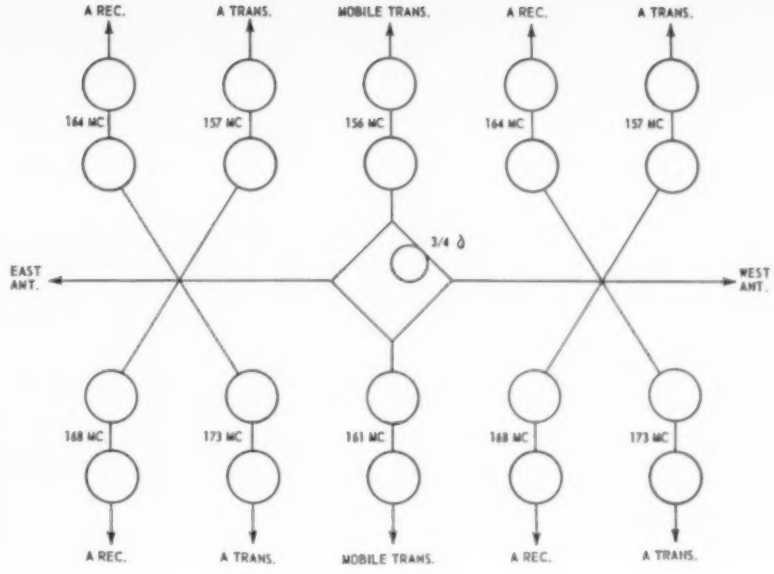


FIGURE 7—Arrangement (right) of cavity filters at KM 1013 relay station. RG8/U cable is used for interconnection. Lengths are odd numbers of quarter-wave lengths at 165 mc, except those connecting to antenna junctions which are adjusted for minimum standing wave ratio. Approximate frequency of each branch is shown.

mined. This unit is satisfactory for the present purpose. It is planned to install an IF combining system in the future.

Voice Channel Performance. The derived channels terminate in operators' switchboards at Beirut and Turaif. Manually keyed tones in each channel are used to light the calling lamps on the distant switchboard. It was necessary to reduce the planned deviation of the transmitters by the carrier channels by 6 db in order to reduce crosstalk into the non-compandored physical channel to the level shown in Table 1. This produces a median 40 db S/N in the carrier channels on a test tone level to weighted noise basis. With the compandor improvement, satisfactory channels are provided.

The physical channel (oil dispatch-mobile relay channel) is available at the operating positions of the Beirut oil dispatcher and the pumphouse operator in Turaif. It is also available at the Qaryatain pumphouse, although this is normally unattended, and the office and home of the Qaryatain station supervisor.

A transistorized speech clipper unit provides 10 db of speech clipping on this channel. Maximum output is limited to a value which produces 5 kc deviation of the transmitters. A low-pass filter at the output of the unit prevents distortion products from interfering with the tone or carrier channels. Speech clipping would not be advantageous in some of the noisier talking locations while using the standard microphones in the handsets. All handset microphones in noisy locations were replaced by noise-cancelling units. These reduce pickup of ambient noise by 15 db.

In noisy locations such as the gas turbine pump house at Turaif, higher than normal receiver levels are of value. By maintaining the oil dispatch-mobile circuit on a four-wire basis receive levels of 0 dbm are used without risk of singing. The operating consolettes at Beirut and Turaif have a provision for switching in a resistance hybrid and on appropriate pad to allow connecting the circuit to the telephone systems, if required.

Mobile System. Table 3 lists some of the characteristics of the Mobile System.

Table 3—Mobile System

1. **Modulation**—Phase
2. **Transmitter Power**—250 watts except 50 watts at Sidon Terminal
3. **Maximum Deviation**—± 15 kc
4. **Receiver Bandwidth**—40 kc
5. **Receiver Sensitivity**—20 db quieting for .6 uv input
6. **Maximum Talk-Back Range**—50-60 miles
7. **Telemeter Channels**—Four 3400, 3600, 3800 and 4000 cycles, time-shared
8. **Deviation for Telemeter Tones**—7.5 kc
9. **Deviation for Voice (max)**—7.5 kc
10. **Speech Clipping**—10 db
11. **Calling Tone Frequency**—3000 cycles

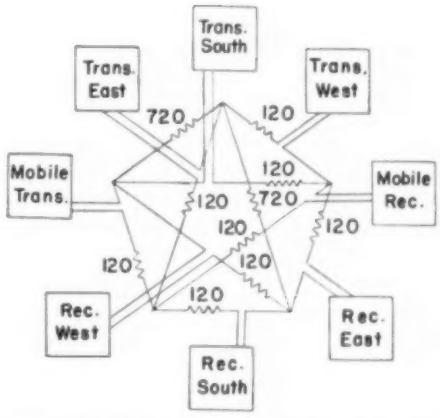


FIGURE 8—Pentastar hybrid network. Each receiver modulates all transmitters, but is isolated from the transmitter, serving the same direction as the receiver. Transmitters or receivers may be inserted in the unused branches if required.

In the western sector complete coverage along the pipe line and nearby roads is provided. Beaufort and KM 1013 provide coverage for cars out of range of Sidon and Turaif. Through this circuit the Beirut oil dispatcher can maintain immediate contact with line patrol or repair activities in this sector. In Arabia coverage is provided between the remote controlled station and the controlling station. A tone calling transmitter is installed in each radio vehicle to provide positive calling to the pumphouses or oil dispatcher. A dual-front-end receiver is employed to permit reception of both

FIGURE 9—Gas turbine pump house at Qaryatain, Jordan.

base stations and relay stations. The transmit and receive frequencies at relay stations are separated by approximately 5 mc to allow use of the antenna array for both functions simultaneously. Talk-back range into the corner reflector arrays from a car with a roof-mounted ¼-wave whip is 50 to 60 miles.

It is planned to install E88CC cascade preamplifiers feeding all mobile base station and relay station receivers. This will reduce the overall noise figure of the receiver by approximately 5 db increasing the ultimate talk back range by approximately 5 miles.

Tower, Antennas and Transmission Lines. Details of the tower and corner reflector antenna arrays at KM 1013 are these: the tower is 200 feet high, 33 feet square at the base and 7 feet 8 inches square in cross section for the top 53 feet. A hand winch, to which-an electric motor can be attached is available for lifting materials.

The eight platforms and top plate are spaced two meters apart. These, along with the guarded ladder make the tower feel relatively safe, facilitating any necessary work on the antennas or transmission lines by radio technicians. The tower is designed to withstand 30 psi wind pressure on flat surfaces with the antenna installation shown.

It proved very important to insure that all metallic attachments to the towers such as conduits, winch cables and guard chains were securely fastened so that they do not hit against the tower in the wind. Intermittent noise interference was traced to this source in several instances.

The thirty-two individual corner reflectors comprising the array are stock models with slight modifications. They were assembled in groups of four on the ground. The stacking harness is designed to allow using an array of 4, 8 or 16 should it become necessary to disconnect a portion of the antenna for maintenance. The median gain measured on installed antennas is 22 db over a dipole. The standing wave ratio is well below 1.5 to 1 over the 156-174-mc band.

The antennas themselves are generally approximately 180-feet above the ground. At Beaufort Relay the effective height is at least several hundred feet as the antenna is mounted on a 100 foot tower which is near the edge of a precipice. Thus in all cases the antenna arrays are at greater heights than one-half vertical correlation distance which is

$$D_v/2 = \lambda a/2d$$

where a = modified earth radius

d = path distance

according to Gordon.[7] This is approximately 150 ft. for the present case. During the afternoon hours, when the scatter mode of propagation prevails, no appreciable further gain is available at 160 mc by further elevation of the antennas. Fortunately, this height is also sufficient to provide adequate mobile coverage.

Antenna-Duplexing Filters. Figure 7 is a schematic diagram of the array of cavity filters shown in Figure 5. Each cavity is rated at ½-db insertion loss. The median measured loss between a transmitter or receiver and the common junction to which the transmission line connects is 1.7 db. Attenuation of transmitter noise at receivers is 65-85 db. This is sufficient so that transmitter noise is not detectable in the receivers. Attenuation of transmitter voltages at the receiver inputs is of the same order and there is no detectable desensitization of the receivers. The ¾-wave bridge splits the mobile relay transmitter power between the two directions and allows the mobile receiver to be fed by both antennas. At the same time, the two antenna junctions are effectively isolated from each other. In assembling this system it proved very important to make neat, secure connections between the cables and the terminating plugs. A finished assembly is required to pass a "shake and bend" test while listening for noise in the receivers. Tune-up of the system is accomplished with the aid of a feed-through type directional wattmeter.

Relay Station Equipment and Circuitry. Equipment at KM 1013 includes transmitters, receivers, diversity combiners, and monitor rack. This station is equipped with an air conditioning system. Temperatures at this location peak at 105-110 degrees during summer days. Four independent refrigerant circuits are employed to minimize the possibility of a complete air conditioning failure. Should this occur a temperature actuated system will disconnect all primary power. Two to three of the four compressors will generally carry the load leaving some margin for maintenance. The building is sealed and has no windows.

The power plant is in a separate building and a few yards from the radio building. Two 30/KVA air-cooled diesels are employed. Automatic switch gear controls the cycling of the two units and starts the standby unit should the operating unit fail. A month's supply of diesel fuel is available in a storage tank in a separate room. The reliability of this plant has proved excellent.

A pentastar hybrid[8] facilitates the tieing in of the spur link to Qaryatain Pump Station on a baseband basis

and provides connections for the mobile system relay transmitter and receiver and a future telemeter receiver. The pentastar network, Figure 8, is fabricated of ordinary unselected 5 percent carbon resistors. It provides a 25 to 35 db loss between transmitters and receivers which are to be isolated and approximately 9 db insertion loss between other sets of terminals.

Remote Control of Pump Stations. Figure 9 shows the 5,000 HP combustion gas turbine pumping station at Qaryatain, Jordan. This installation is controlled remotely from Turaif pump station in Saudi Arabia via the KM 1013 relay station. The Turaif pumphouse operator can start and stop the turbine and set the discharge pressure which the unit produces.

These control functions are provided by an all-relay code selector system. The system is interlocking so that no operating function is performed by the system without a signal from the remote unit confirming that the proper function selection has been made. Thus the turbine cannot be shut down, for instance, by noise or interference on the radio system. The supervisory system display at the master station indicates valve positions, completed starting sequence of the remote turbine and various malfunctions which are graded as first, second, or third order depending on the importance of the malfunction. A procedure is provided for checking the proper operation of the supervisory equipment itself.

The Qaryatain turbine and the remotely controlled turbines in Arabia are self-monitoring and self-protecting units. The starting and stopping sequences are automatic once they have been initiated. The remote control functions are thus simplified and made less critical.

Figure 9 shows the Qaryatain pumphouse with the tower and antennas mounted on the roof.

Telemetering. Discharge pressure, suction pressure, air temperature and discharge pressure control system set point are telemetered to Turaif and to the oil dispatching office in Beirut via KM 1013 relay station. The telemeter tones which consist of 10 to 30 cycle modulated frequency-shift tones of 3,400, 3,600, 3,800 and 4,000 cycles, modulate the mobile relay system and are received in Turaif and Beirut over this system. The mobile relay transmitters and receivers were modified to extend the frequency response to 6,000 cycles and provide separate inputs and outputs for the voice channel and the tone channels.

The tones are not on continuously but are sequenced with each tone on for 1½-seconds. One-half the mobile system deviation is used for the tones providing a good signal-to-noise ratio in the tone channels down to the receiver squelch point. As this is not a diversified system and the system gain is of the same order as the point-to-point system, from time to time the signal will fade below the squelch level of the receiver (.7 uv). When this occurs, the recording pens maintain the last position until the signal reappears. No loss of data occurs as the fades are short compared to the rate of change of the measured quantities. Should a failure of the tones occur for any reason the recording pens will return to the zero point on the scale within 30 seconds. This same feature holds a pen in its last previous position during the tone-off portion of the commutation period.

Use of the mobile relay system equipment to carry the telemeter tones minimizes the tone loading on the backbone system and avoids future filtering problems when the Arabian links are connected in to the western sector.

The mobile units have low-pass filters installed in the audio amplifier sections of the receivers to filter out the tones. No intermodulation products in the voice band are noticeable at the deviation levels shown in Table 3.

Surge Protection Trip. The surge protection trip function, mentioned earlier, reduces to idle speed the turbines at Turaif pumphouse whenever the Qaryatain turbine trips off the line for any reason. The positive surge of pressure generated at Qaryatain when this occurs travels back toward Turaif at a speed of approximately one kilometer per second. Within a short time certain critical points between Qaryatain and Turaif, points where pipe wall thickness changes, will be overpressured unless a negative surge is initiated from Turaif within a few seconds. The rapid reduction to idle speed of the turbines at Turaif provides the negative surge.

The surge protection trip signal is provided by a 3,750 cycle frequency-shift tone carried by the dual-diversity backbone system via KM 1013 to Turaif. This tone shifts from space frequency to mark frequency when a trip occurs. A three-second delay in the response of the receiver at Turaif bridges across momentary lapse in the signal such as those caused by momentary propagation outages.

The system must be as fail-safe as possible as the consequence of an undetected failure could be a ruptured pipe line. This is accomplished by causing the tone to rest at space-frequency normally and utilizing a mark-return feature in the receiver which actuates the pressure-reduction function should a failure of the tone occur. Failure of any power supply or transmitter tube will cause a pressure-reduction, as will failure of any tube in the receiver with the exception of one which is operated with plate current normally cut off. A second tube wired in parallel and frequent testing minimize this risk.

At Qaryatain a surge tank is necessary in addition to the pressure-reduction function. In the eastern sector of Tapline the base station pressure reduction alone protects against overpressuring the critical points.

This system has been generally satisfactory. No failure to reduce pressure chargeable to the communication system or tone equipment has occurred in the first year and one half since they were installed. Unnecessary pressure reductions from all causes have been infrequent.

Plan For Expansion of the System. On the basis of the performance of the system to date, it has been decided to install the three links required to complete the system over the entire 754 miles of the pipe line. Facilities to be provided by the completed system are:

1. Oil dispatch and mobile voice circuit
2. Two teletype circuits—oil dispatch and general purpose.
3. A small number of interdialing trunks between the major locations.
4. Supervisory control, telemetering, and surge protection trip functions.

Economic Factors. Needless to say, in all stages of the design and construction of any new facility, such as

a communication system, unremitting efforts must be made to achieve the essential functions at the lowest possible total cost. This is perhaps especially appropriate for investments in remote areas.

The number and necessary quality of the voice channels required by a private industrial user can easily be overestimated leading to a wide-band costly system. In situations where wide latitude is permitted in the choice of operating frequencies, we believe that the type of system described represents good value in terms of functions and services provided for a given minimum investment.

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ACKNOWLEDGMENT

From a paper presented at the Fifth National Communications Symposium of the Institute of Radio Engineers, Utica, N. Y.

About the Author

John D. Hoffman, assistant chief engineer (Communications) of Trans-Arabian Pipe Line Co., obtained a B.S. degree in electrical engineering from the University of Minnesota in 1950. Since that time he has been employed by Trans-Arabian Pipe Line Co. He has held his present position since May 1958. He is a senior member of the Institute of Radio Engineers.

and purpose is to prevent outage when the main unit, which the standby is protecting, fails. Should this ability be anything less than 100 percent reliable, and tend to actually increase outage time because of this factor, the installation and justification of conventional standby leaves much to be desired. This author has witnessed numerous instances when false switching to standby occurred. The standby unit was defective and the system was out until a maintenance man could arrive at the site. What makes this type of occurrence so frustrating is that the main unit was functioning properly until it was removed from operation by the false switchover. With the dual-beam system failures of any of the R.F. units is immediately alarmed, therefore, the working status of the entire system is known at all times.

5. Outage for checking. One problem encountered by technicians maintaining standby equipment is finding the opportunity to check such equipment.

With either the "hot" or "cold" standby equipment this final check of the equipment is an absolute necessity. If the maintenance man is not positive the standby unit will operate satisfactorily, and may interrupt traffic when placed into service, he is usually required to wait until all the channels are clear of traffic. This takes time. If the standby is not functioning properly the maintenance man attempts to locate the problem as quickly as possible; however, outage time is being incurred and he is working under considerable pressure. This is not conducive to good maintenance. This problem also affects maintenance or trouble clearance on a main R.F. unit when the station is on standby. The equipment has to be placed in actual operating service before the status of the defective unit is fully known.

Because each R.F. path of the dual beam system is independent of the other, the maintenance man can perform his routine work, or trouble clearance under actual operating conditions without disturbing traffic. This is the tremendous advantage of a dual beam system.

Costs. In comparing the cost of a dual beam system with a system employing conventional standby

Continued from Page 43

equipment, the comparison is very favorable. Compared with a system employing 100 percent standby equipment, the cost comparison resolves to two additional transmission lines to the top of the microwave tower, and the special center-fed polarized horn driven parabolic reflector, versus the switchover and sensing equipment of the standby unit and the conventional dipole parabolic reflector.

Compared with a system employing 50 percent standby equipment, the cost comparison is similiar to the above with the exception, of course, that an additional R.F. unit consisting of one transmitter and one receiver is required for the dual beam system.

In conclusion it can be stated that the installation of a dual beam microwave system cannot by itself guarantee a 99.9 percent plus reliability factor if the basic design of the R.F. and associated equipment, or the routine maintenance program, is not sound. However, with everything being equal, it has demonstrated conclusively its superiority to systems employing conventional standby equipment and should, for its users, bring them much closer to the ultimate goal of 100 prcent reliability.—**The End**

About the Author

G. V. Morck is assistant superintendent of communications for Sinclair Pipe Line Company. His job is to supervise construction and maintenance of microwave systems and also electrical installations related to automatically controlled pump stations located within Sinclair Pipe Line's Eastern Division extending from Chicago to the Eastern Seaboard. Morck has 17 years military, commercial and industrial experience with the U.S. Army Signal Corps, Western Union Telegraph and Sinclair. He has received training in U.S. Army and Bell Telephone System schools, University of Wisconsin and Capital Radio Engineering Institute in Washington, D. C.

Local Automation at Transwestern's Unattended Compressor Stations

Remote supervision depends on assured local starting and stopping of the units

By R. W. Smith, Jr., Chief Electrical Engineer and

J. G. Vletas, Electrical Engineer, Gulf Interstate Co., Houston

FROM FIRST TO LAST, Transwestern Pipeline Company's compressor stations are designed for unattended, automatic operation.

The stations are almost identical. Each one is powered by two 3,500 hp LSV 16's driving RFB-24 centrifugal compressors through a gear speed increaser (See PIPE LINE INDUSTRY August, page 30-38). This equipment is proving flexible, efficient and reliable. What's more, the engines are easy to start; this is very important.

What are the engine requirements for automatic operation? From a control standpoint, the selection of the above equipment was indeed fortunate. The excellent flexibility of the compressor package is the prime reason why simple speed control is sufficient to provide operational gas control along the mainline. But this characteristic alone is not sufficient to justify its use in a fully automatic unattended compressor station. It must also be easy to start and the starts must be as near 100% successful as can be achieved. The combination characteristics of easy starting and flexibility in operation as found in this particular compressor package are the fundamental reasons why Transwestern's mainline stations are expected to be so successful in automatic operation.

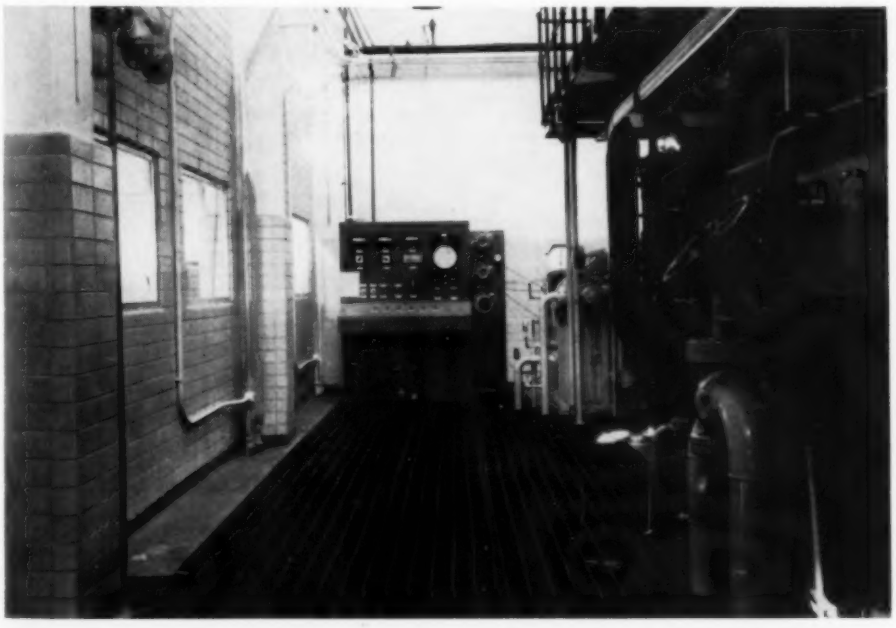
Starting the engine is the most critical control operation at any automatic station. Once an engine is started and placed in service, it is a fairly easy control job, but the true mark of an automatic station is the automatic starting and stopping of the units. This problem has been successfully handled at the new Transwestern stations. Once the *start* or *stop* order is initiated by the dispatcher, the controls proceed with the execution of the orders in a smooth and safe manner.

Before acting to start the engine remotely—Actually, the controls are already on the job before the dispatcher can start an engine. A number of functions must be satisfied before the start controls will accept a start order, or in other words, the controls must have operated properly on the unit during the previous stopping of the engines. Functions that must be in the proper order before the command to start can be accepted are as follows:

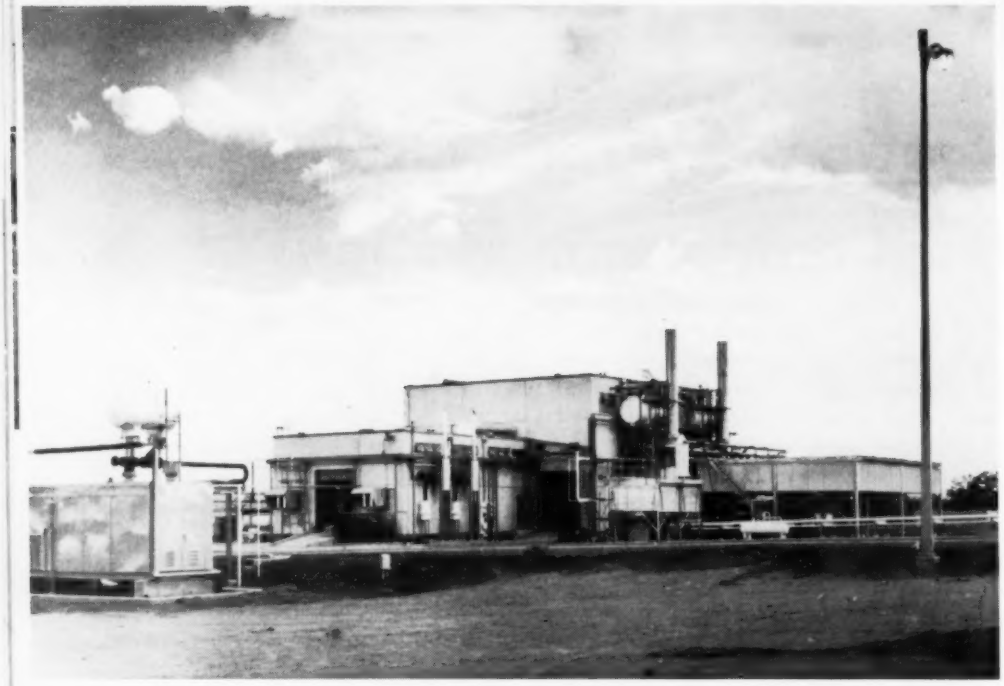
1. Manual-Automatic selector switch on the engine panel must be in the automatic position.
2. Remote-local switch on engine station panel must be in the remote position.
3. Ignition relay on engine must be open.
4. Main fuel gas valve must be open.
5. Safety fuel gas valve must be closed.
6. Suction, discharge and purge valves must all be in a closed position in the gas piping to the compressor.
7. Blowdown valve must be in the open position.
8. Engine run remote relays must be energized.

A number of controls are normally by-passed at the beginning of the starting sequence to allow the unit to start. Functions of this type are:

1. Compressor Vibration
2. Gear Vibration
3. High Jacket Water Temperature
4. Low Engine Oil Pressure
5. Low Gear Oil Pressure
6. Low Compressor Oil Pressure
7. Low Turbocharge Oil Pressure



Each of the 3500 hp gas engine driven centrifugal compressor units have individual control consoles. Engine start-up sequence begins only when specified conditions exist. Starting or stopping will come on command of dispatcher in Roswell.



LONELY STATION at Thoreau, N. M. will be remotely supervised from Transwestern's ultra-modern control center now nearing completion at Roswell, N. M. But actual operation for the most part will be controlled by local instrumentation.

8. Low Compressor Seal Oil Level
9. Low Compressor Seal Oil Accumulator Tank Level.

Pushing the "button." When the above conditions have been satisfied, the starting controls are ready to accept the dispatchers engine start order. From the central office in Roswell, N. M., the dispatcher selects the proper station, and the proper engine at that station and pushes the "engine start" button. To actually send the order to the station, he must then depress the "Data Send" button and the order is encoded and transmitted to the station. During the actual starting of the engine, the "Engine Run" indicating light on the Roswell display board will be flashing off and on. This continues until the engine is running properly and is placed on the line. The light then burns steadily.

If the engine fails to start, the light goes out and another light, either "Shutdown Restart" or "Shutdown Lockout" comes on to indicate which type of shutdown has prevented the engine from starting. If it is a function that permits a restart, the dispatcher may again initiate the "Engine Start" order to the station.

Shutdown-Restart functions that apply, not only to the starting sequence, but also protect the engine during normal operation are:

1. High Engine Oil Pressure
2. High Gear Oil Pressure
3. High Engine Oil Temperature
4. High Gear Oil Temperature
5. High Seal Oil Accumulation Tank Level
6. Low Seal Oil Accumulation Level
7. High Seal Oil Tank Level
8. Low Seal Oil Tank Level
9. High Engine Oil Level
10. High Jacket Water Temperature
11. High Starting Air Temperature
12. False Compressor Valve Positions
13. High Compressor Case Temperature
14. High Compressor Thrust Bearing Temperature
15. Compressor Seal Leakage
16. High Discharge Gas Temp
17. Engine Overspeed
18. Starting Sequence Fault

Shutdown-Lockouts. If during the starting sequence, another class of functions cause the unit to be shutdown, the dispatcher would not be allowed to restart the unit. Functions of this type are identified as "Shutdown-Lockout." They protect the unit in normal operation as well as during the starting sequence. Those functions are:

1. Fan Vibration
2. Engine Vibration
3. Gear Vibration
4. Compressor Vibration
5. Gas Piping Vibration
6. Low Engine Oil Pressure
7. Low Turbocharger Oil Pressure
8. Low Gear Oil Pressure
9. High Engine Crankcase Pressure

Re-starting. These functions require the station personnel to go to the engine and reset the controls and correct the trouble if necessary before the dispatcher can restart the unit. This applies primarily to normal operation of the unit; however, a number of the functions are by-passed during the early stages of the starting sequence.

When the "Engine-Start" order is received at the station, the signal is decoded and the start relay is engaged. From this point, on into the starting sequence, the controls are designed for series or sequential operation. This important design technique results in a fool-proof control system, with the end result being the safe successful starting of the engine and the proper placing of the unit on the line.

The series technique and what it means. As applied to Transwestern's controls systems, the series technique simply means that each step in the starting sequence must be satisfied before the next step is allowed to take place. The only possible drawback to this type of system is that if a single event in the series of events is not satisfied properly, the starting of the unit would be delayed until that event was satisfied. In an extreme case, this might mean that in an unattended station, an engine might require several hours before it would be started —if it started at all.

"Watch dogs." To guard against this, a number of "watch dog" timers are utilized. They constantly monitor key steps in the starting sequence. Should a particular event require more time than that previously determined, the "watch dog" timers would shut down the unit and the unit annunciator would display a starting sequence fault flag. However, this allows the dispatcher an attempt to restart the unit.

THE STARTING SEQUENCE

As the start control relay is energized, the seal oil fill pump is activated until such time as the seal oil level is satisfied. At this time, a two-minute timer monitor is energized. When the level in the seal oil tank is satisfied, seal oil is then directed from the tank into the compressor bearings. The two minute starting sequence timer will be satisfied if the engine is

up to at least 200 RPM within the allotted time.

As the seal oil level control is satisfied, the purge valve opens. The blowdown valve closes after a 15 second purge and a pressure of 105 psi is allowed to build up in the compressor case at which time the purge valve closes.

The starting air valve is opened at this point, and air is admitted to the engine. It then accelerates up to 50 RPM on starting air. At that speed, an engine air purge timer holds the engine at 50 RPM to sweep out or purge the engine of possible fuel gas that may have accumulated in it before ignition is applied. After the engine air purge time has elapsed, the ignition relay applies ignition to the engine. The ignition repeater relays then allow the safety fuel gas valve to open. The engine, now running on the starting fuel gas, accelerates past the 200 RPM speed to about 240 RPM. This satisfies the two minute timer previously energized when the seal oil level control was first satisfied. At the 200 plus RPM speed, the seal oil fill pump is shut off, the starting air valve is closed and another timer is activated. This monitor allows a period of five minutes during which the valves to the centrifugal compressor are to be opened.

At the same time, the main fuel gas valve is allowed to open fully, and the engine oil pressure by-pass timer is started. A one minute period is allowed by this timer, after which all low oil pressure controls are placed in service. As mentioned above, a number of these safety shutdown controls were by-passed during the first part of the starting sequence.

As the main fuel gas valve opens, two relays are closed. One re-opens the purge valve allowing gas to enter the compressor case and the pressure to build up in the case from 105 psi to full suction pressure. The second relay activates the set point change timer. This monitor allows 45 minutes for the unit to build up the discharge pressure to within eight psi of the set point pressure. If the unit does not satisfy this condition, an alarm will be indicated through the set point deviation relay.

When the compressor case is fully pressured to suction pressure, the discharge valve is allowed to open fully. When the latter is fully open, the suction valve is then allowed to open, thereby, loading the compressor. At this time, the purge valve is closed. When the suction valve is fully opened, a relay deactivates the five minute timer that was monitoring the loading of the compressor. If the loading had taken more than five minutes, this timer would shutdown the unit, but would have allowed the engine to be restarted.

As soon as the suction valve is fully open, there are a number of functions that must be satisfied to prevent the unit from being shutdown on engine valves "false position." These functions are:

1. Purge Valve Closed
2. Suction Valve Open
3. Discharge Valve Open
4. 200 RPM Speed Relay Energized
5. Blowdown Valve Closed

In addition to these functions, additional controls that were originally by-passed in the early stages of the starting sequence are now placed in service. These functions are the *compressor and gear vibrations and the high jacket water temperature.* Next, the flashing run light which has been indicating an engine start up, starts burning steadily indicating that the engine is on the line. At this time, the speed of the engine is slowly increased until it matches the speed of the other engines. During this period, the engine warms up and eases into its load. Thus the starting controls are fully satisfied and control now passes smoothly over to the discharge pressure controller for operational control.

Placing a Second Unit On the Line. The above sequence applies to starting all main line engines. However, in the case where an engine at the station is already running and a second unit is to be placed on the line at the same time, a special provision is made to prevent surging or abnormal pressure increases.

In this case, the running engine is gradually slowed to some speed above the minimum speed. Once the unit being placed on the line is loaded, and starts its gradual speed increase (during the warm-up period), the first (or running) engine speeds up at a faster rate to more quickly re-establish the original discharge pressure. This minimizes over-shoot of the discharge pressure set point.

Should the second (or cold) engine fail to start, an alarm is sounded both at the station and in Roswell. The speed of the operating unit, which had been reduced to bring the second engine on the line, is automatically raised to whatever speed within the operating range is necessary to satisfy the discharge pressure set point. If the discharge pressure is not within 8 psi of the set point within a 45-minute period, a set point deviation alarm is sounded, and the corrective steps can then be taken.

When both units are operating. Once the units are in operation, the various operational controls take over the supervision of the operating engine. The Shutdown-Lockout and Shutdown-Restart controls will safeguard the unit from malfunctions that may occurs during normal operation. There is a third group of controls which also aid in supervision of the units. These controls merely sound alarms to alert the station personnel (should they be present), that a situation has arisen which should be investigated. Sufficient time is allowed by this group of alarm controls for corrective steps to be taken. However, if the particular situation is not corrected, the shutdown controls will then come into play to shut the unit down, thereby protecting it. These alarm-type controls safeguard the following functions:

High Seal Oil Differential Pressure
Seal Oil Level Warning
Low Engine Oil Level
Low Gear Oil Level
Low Jacket Water Surge Tank Level
Low Oil Cooling Water Surge Tank Level
Water Pump Seal Leak

For all groups of shutdown and alarm controls, a flag is displayed in the annunciator board to identify the malfunction. Only the first malfunction is identified so that the original difficulty is singled out.

A complete schematic layout of the complete automatic controls installed at Transwestern's mainline compressor stations is shown in the accompanying drawing. This schematic clearly indicates which data is transmitted to and from an automatic station and the Roswell control center. Note that the dispatcher is kept constantly informed as to the operating conditions that exist at each automatic compressor station.

SHUTTING ENGINES DOWN

An engine stop may originate with the dispatcher or it may come during any part of the starting sequence or during operation as a result of a mal-

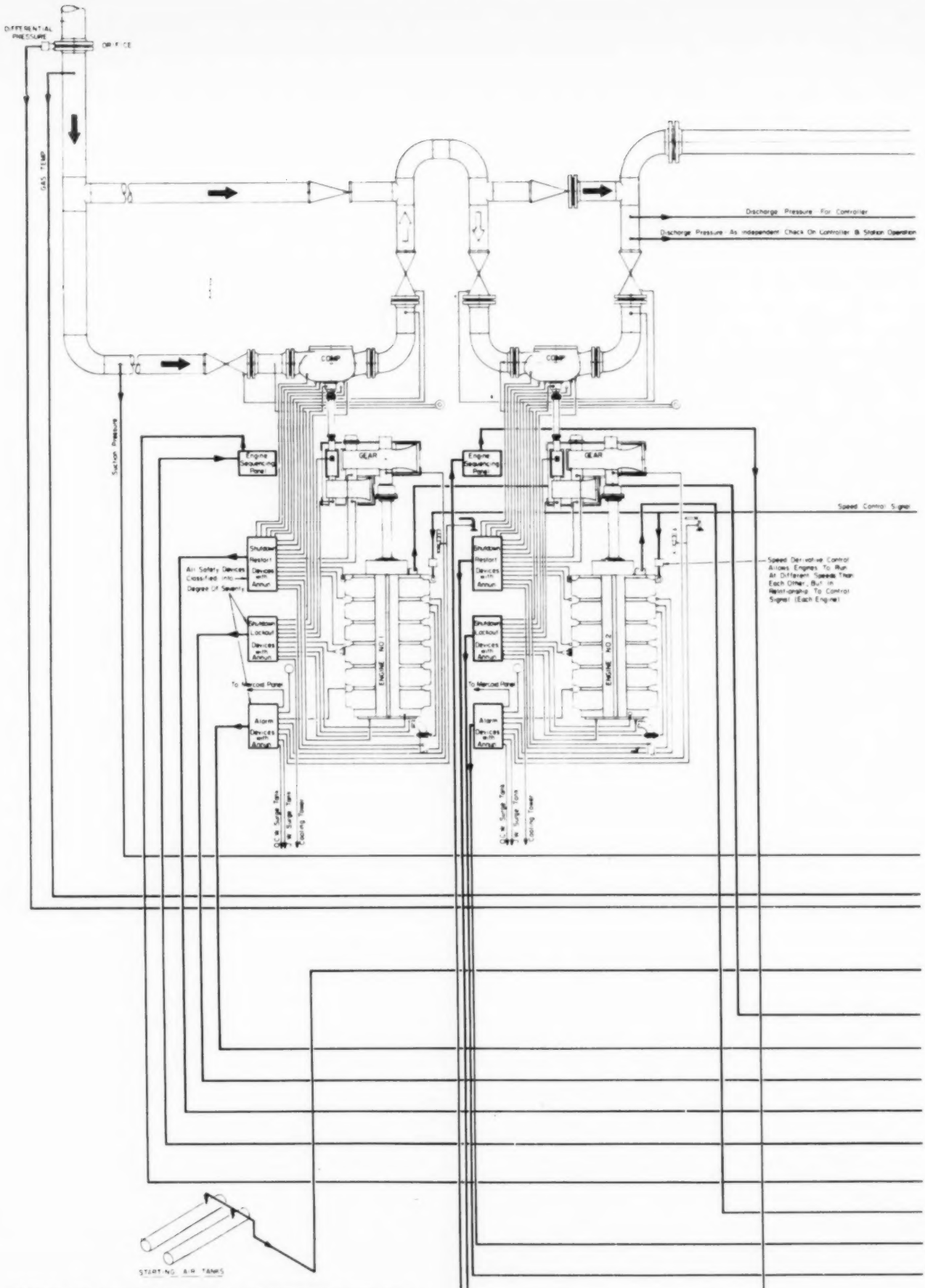
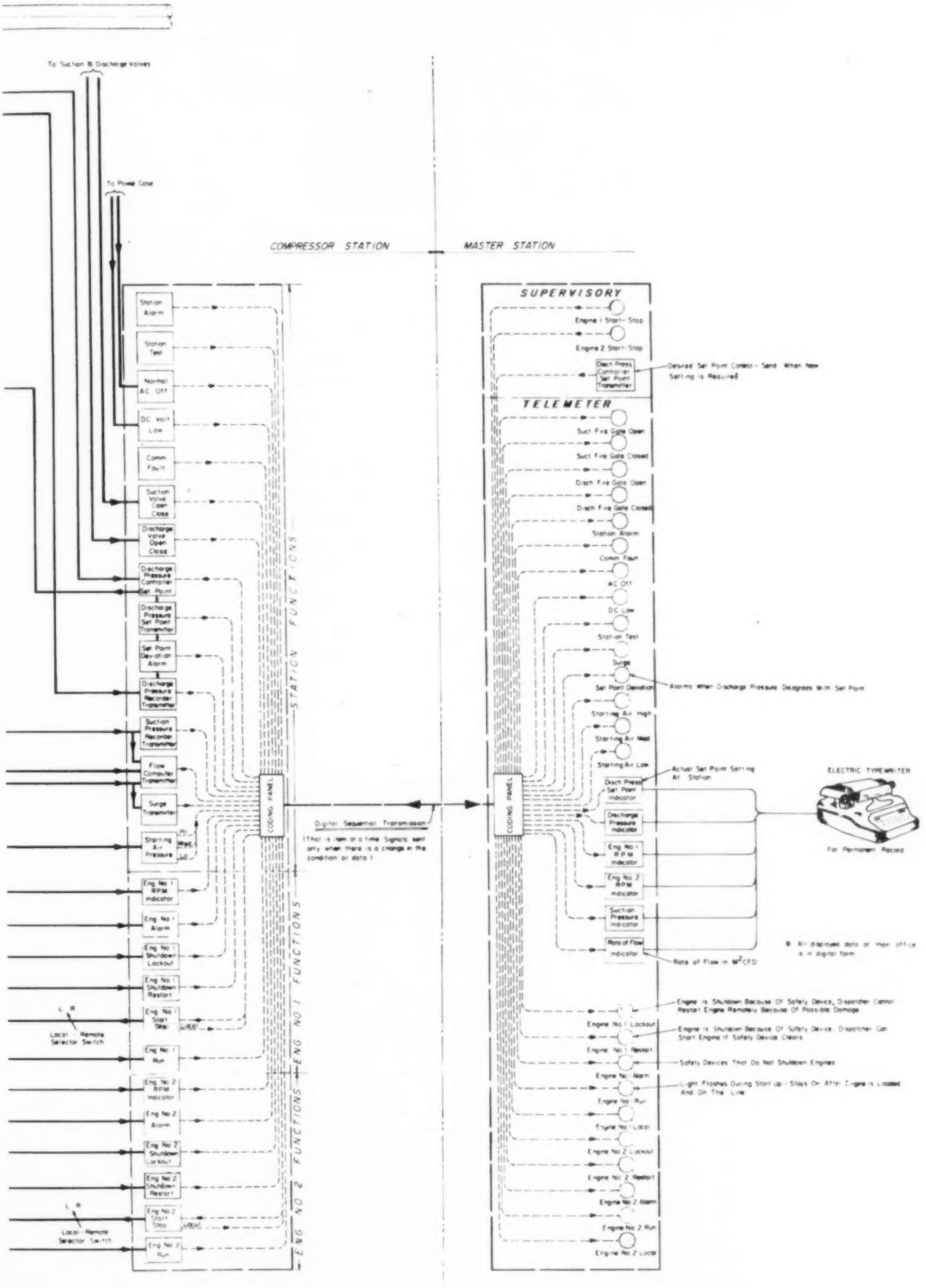


DIAGRAM OF REMOTELY CONTROLLED STATION. Shown at right is information from the station which is available at the Roswell control center. During engine startup a number of shutdown devices are temporarily by-passed.


To Suction & Discharge Valves
To Power Case
COMPRESSOR STATION
MASTER STATION
SUPERVISORY
Engine 1 Start-Stop
Engine 2 Start-Stop
Disch Press Controller Set Point Transmitter
Desired Set Point Control - Send When New Setting is Required
TELEMETER
Suct Fire Gate Open
Suct Fire Gate Closed
Disch Fire Gate Open
Disch Fire Gate Closed
Station Alarm
Comm. Fault
AC Off
DC Low
Station Test
Surge
Set Point Deviation
Alarms When Discharge Pressure Disagrees with Set Point
Starting Air High
Starting Air Med
Starting Air Low
Station Alarm
Station Test
Normal AC Off
DC volt Low
Comm. Fault
Suction Valve Open Close
Discharge Valve Open Close
Discharge Pressure Controller Set Point
Discharge Pressure Set Point Transmitter
Set Point Deviation Alarm
Discharge Pressure Recorder Transmitter
Suction Pressure Recorder Transmitter
Flow Computer Transmitter
Surge Transmitter
Starting Air Pressure
Eng No 1 RPM Indicator
Eng No 1 Alarm
Eng No 1 Shutdown Lockout
Eng No 1 Shutdown Restart
Eng No 1 Start Stop
Eng No 1 Run
Eng No 2 RPM Indicator
Eng No 2 Alarm
Eng No 2 Shutdown Lockout
Eng No 2 Shutdown Restart
Eng No 2 Start Stop
Eng No 2 Run
L R
Local - Remote Selector Switch
CODING PANEL
STATION FUNCTIONS
ENG NO 1 FUNCTIONS
ENG NO 2 FUNCTIONS
Digital Sequential Transmission
(That is item at a time. Signals sent only when there is a change in the condition or data.)
Actual Set Point Setting At Station
Disch Press Set Point Indicator
Discharge Pressure Indicator
Eng No 1 RPM Indicator
Eng No 2 RPM Indicator
Suction Pressure Indicator
Rate of Flow Indicator
Rate of Flow in MCFD
ELECTRIC TYPEWRITER
For Permanent Record
* All displayed data at main office is in digital form
Engine is Shutdown Because Of Safety Device, Dispatcher Cannot Restart Engine Remotely Because Of Possible Damage
Engine is Shutdown Because Of Safety Device. Dispatcher Can Start Engine If Safety Device Clears
Safety Devices That Do Not Shutdown Engines
Light Flashes During Start Up - Stays On After Engine is Loaded And On The Line
Engine No 1 Lockout
Engine No 1 Restart
Engine No 1 Alarm
Engine No 1 Run
Engine No 1 Local
Engine No 2 Lockout
Engine No 2 Restart
Engine No 2 Alarm
Engine No 2 Run
Engine No 2 Local

Computer in the control center in Roswell has Transwestern Pipeline system characteristics built in. This analog computer solves problems for the dispatcher relating to discharge settings etc.

function. If the stop signal originates with either a Shutdown-Lockout or a Shutdown-Restart control, the shutdown is considered an emergency and the engine is shutdown immediately. In a normal shutdown the engine is first removed from the control of the discharge pressure controller and gradually slowed down to minimum speed. As the speed is reduced on the unit being shutdown, the speed of the other unit is increased to maintain a stable discharge pressure. By this method, the chances of a sharp "bump" in line pressure is minimized.

In the case of the emergency shutdown, the unit is shut down from its operating speed immediately by closing off the safety fuel gas valve. Once this valve is closed, the shutting down of the engine proceeds in a sequential manner. The unit loses speed and at 50 RPM the ignition is grounded.

At this time, a relay operates, and the suction and discharge valves to the compressor are closed. When these valves are fully closed the blowdown valve opens and the compressor case is blown down. When the unit stops, the positions of the valves are rechecked for proper position. If a fault is detected, an alarm is sounded. In this manner, the unit is left automatically in a position so the controls will accept a new start order when it is issued.

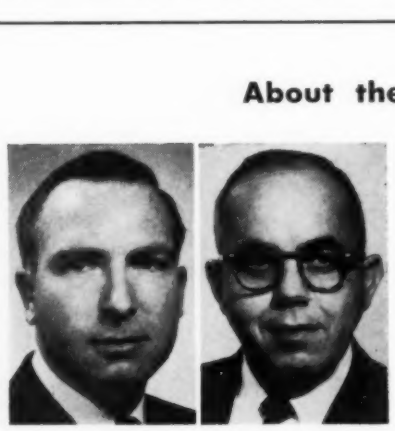
Electro-pneumatic controls. The type of control system used for the Transwestern units can be classed as an electro-pneumatic system. That is, the control *sensing* elements are electric and the *execution* arms of the controls are pneumatic. Combining both types of controls, *electric* and *pneumatic,* allows the use of the best features of both types without the disadvantages of either. It also means that the automatic compressor stations must be completely self-sufficient. An elaborate standby electric power system has been incorporated in the stations to insure continued operation of the units under almost any conceivable set of circumstances.

Electric power. Each station has two large engine-driven generator sets for its normal power supply. In the event *both* generators fail (only one is normally required), the emergency power is supplied by two small standby engine-generator sets. To further back up the emergency power supply, a full complement of storage batteries are available to supply the necessary DC power for at least eight hours. At the end of this period, it would be necessary to switch over to the standby manual engine controls. This will let the engines continue to operate on pneumatic controls for at least an additional eight hour period.

In the event of a failure in the telemetering system, the controls at the stations will continue to maintain the discharge pressure according to the position of the set point as it was last positioned by the dispatcher. This condition will continue indefinitely at the station until the set point is altered by the dispatcher when control communications are restored. An option to this method of operation is Local-Automatic Control. This allows the controls to be operated by the station personnel who can receive instructions from the dispatcher by radio or telephone.

The design concepts of safe, reliable, continuous operation have been rigorously applied to all the control systems at Transwestern stations. For this reason, it is expected that TW's unattended automatic compressor station will prove to be safer in operation than a fully manned station. Every possible step has been taken in the design to insure safe, continuous operation of the stations.

About the Authors



Smith Vletas

R. W. Smith, Jr., chief electrical engineer, Gulf Interstate Company, is in charge of the Electrical and Instrumentation Engineering Departments. He graduated from the University of Houston in 1951, with degrees in mathematics and electrical engineering. A former industrial instrumentation sales and application engineer for Minneapolis-Honeywell, he joined Gulf Interstate Company in 1956. Smith was co-designer of the electrical and control systems for the unattended automatic compressor stations on the Columbia Gulf Transmission system. On the Transwestern project, he supervised the design of the electrical and control systems for Transwestern's compressor stations and process plants.

J. G. Vletas, electrical engineer, Gulf Interstate Company, is in charge of the electrical engineering design group. He graduated from The University of Texas in 1948, with a BS in electrical engineering. A former field engineer for the R. C. A. Service Co., Inc., Vletas joined Gulf Interstate Company in 1957. Since that time, he has had an active part in the design of electrical power and sequential control systems for compressor stations. He has been instrumental in perfecting these designs for Transwestern's mainline and booster stations.

Computer Program for a Heated Crude Line

Here's the way to enter this complex problem in a computer

By **Dennis R. Horner**
Royal Dutch Shell,
The Hague, Netherlands and

Paul Fried, Engineer
Royal Dutch Shell,
The Hague, Netherlands

THERE IS no short method for calculating the thruput of a heated pipe line because the differential equations describing the system cannot, in general, be integrated. Pressure drop can be calculated only when the thruput rate is known. This means that a trial-and-error method must be used.

Such a calculation can take several man-days of work using conventional calculating aids. However, this only determines one instantaneous thruput rate which will change as the crudes move down the line. Thus, the mean thruput rate can be obtained only by determining a number of such instantaneous rates and averaging them. This calculation would perhaps run into months. It is almost prohibitive.

In the case of the initial design of a pipe line, such calculations have to be repeated not only for the complete pumping schedule but also for various trial designs before the final choice is made. This is even more time-consuming.

With this in mind, a computer program has been written to do these calculations; and a somewhat simpler version of this program played a considerable part in the design of Compañia Shell de Venezuela's North Terminal System.

The program was written in FOR TRANSIT and then translated for the IBM 650 computer. Because of the similarity to FORTRAN, this means that the program could easily be made to work on most of the IBM 700 series computers also.

Description of Problem

General. The input data must provide a quantitative description of the system. Data must include the following information:

(a) The geometry of the pipe line.

(b) The characteristics and locations of pump stations.

(c) The characteristics and locations of heaters.

(d) The thermal properties (i.e., K-factors) of the surrounding medium.

(e) The order, quantity and physical properties of the crudes comprising the pumping cycle.

Based on these data the computer reports the conditions along the line: *pressure, temperature, Reynolds number,* etc. for different line fills corresponding to various positions in the pumping schedule. As a final output, the computer reports the average thruput for the complete pumping cycle.

Basic Elementary Case. To describe the program it is easier to present first of all a simple case. This is known as the "basic elementary case" (BEC). It is on this that additional complexities can be constructed.

Consider, then, a uniform pipe line pumping one crude only, with a single pump station and a single heater, both at the input end. The computer tackles the problem as follows:

(a) It divides the line into a number of equal intervals.

(b) It makes a first guess at the thruput of the line.

(c) Corresponding to this guessed thruput rate, the computer reads the pressure at the input end of the line off the pump curve.

(d) It calculates the temperature of the crude on leaving the heater.

(e) If the pressure or temperature of the crude, or both exceed the permissible maxima, the computer then substitutes the maximum values for the calculated figures.

(f) The computer determines the viscosity of the crude on leaving the heater, and the Reynolds number.

(g) From the Reynolds number, the type of flow (turbulent, transit or streamline) is determined, and hence the cooling rate and pressure gradient at the exit of the heater.

(h) The computer now moves one interval down the line and calculates the temperature at the end of this interval.

(i) It now computes successively the viscosity, Reynolds number and pressure gradient at the same point.

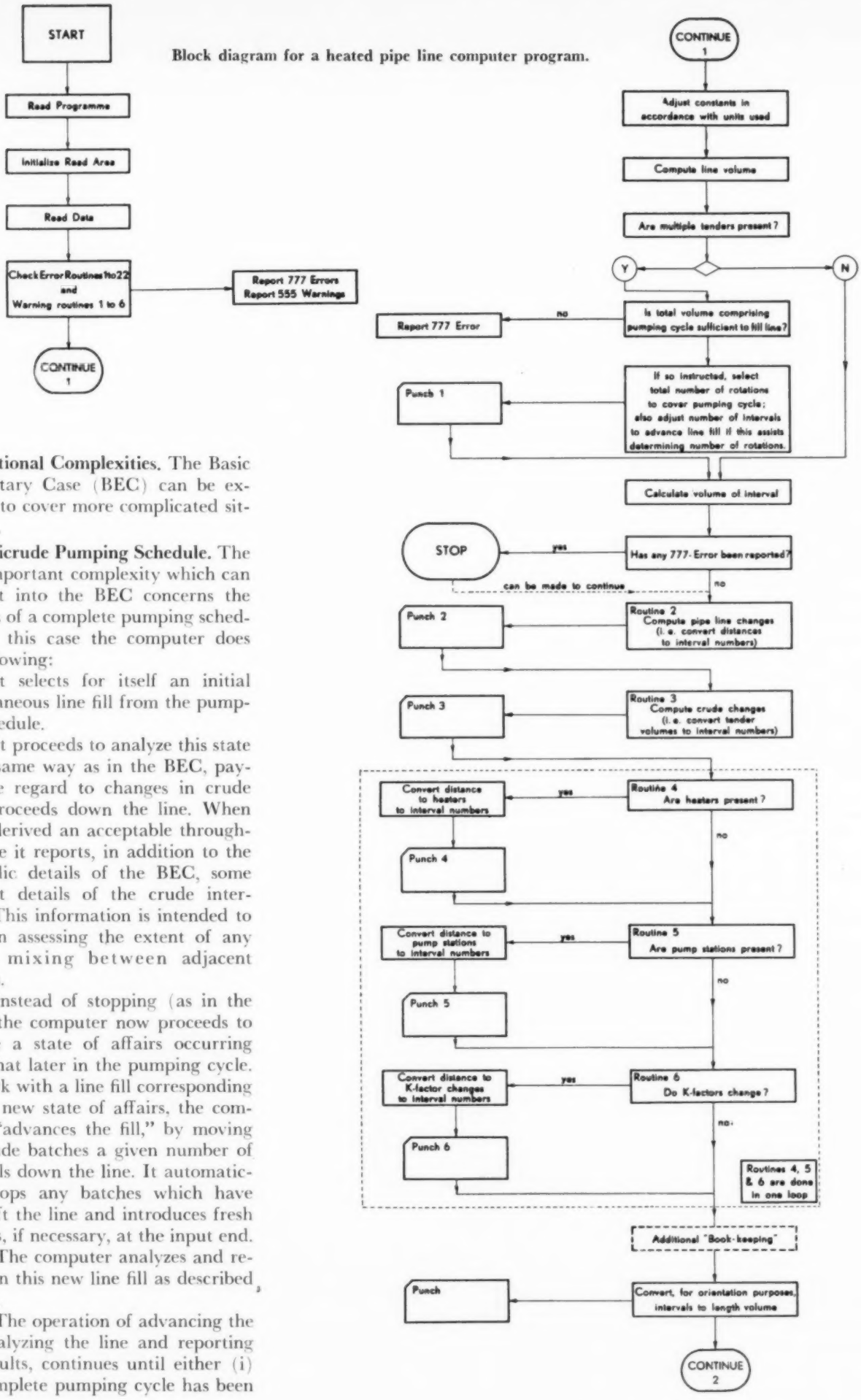
(j) If the flow type has not changed over the interval, the mean of the two gradients is used to determine the pressure drop over the interval. If the flow type has changed, an appropriately weighted average gradient is used for this calculation.

(k) This procedure is now repeated for successive intervals, until each section of the line has been calculated.

(l) If the calculated output pressure does not agree with the value previously laid down for it (i.e., if the guessed thruput rate was not a good one), the computer makes an improved guess and starts again at section c.

(m) Eventually the calculated and specified pressures agree within a certain specified accuracy, and the problem is solved. The computer reports the hydraulic characteristics of the line (pressure, pumping rate, temperature, viscosity and Reynolds number) at each station down the line, and stops.

(For a summary of the equations used by the computer see Table 1.)


START
Read Programme
Initialize Read Area
Read Data
Check Error Routines 1to22 and Warning routines 1 to 6
Report 777 Errors Report 555 Warnings
CONTINUE 1
CONTINUE 1
Adjust constants in accordance with units used
Compute line volume
Are multiple tenders present?
Y
N
Is total volume comprising pumping cycle sufficient to fill line?
no
Report 777 Error
If so instructed, select total number of rotations to cover pumping cycle; also adjust number of intervals to advance line fill if this assists determining number of rotations.
Punch 1
Calculate volume of interval
Has any 777-Error been reported?
yes
STOP
can be made to continue
no
Routine 2 Compute pipe line changes (i. e. convert distances to interval numbers)
Punch 2
Routine 3 Compute crude changes (i. e. convert tender volumes to interval numbers)
Punch 3
Routine 4 Are heaters present?
yes
Convert distance to heaters to interval numbers
Punch 4
no
Routine 5 Are pump stations present?
yes
Convert distance to pump stations to interval numbers
Punch 5
no
Routine 6 Do K-factors change?
yes
Convert distance to K-factor changes to interval numbers
Punch 6
no
Routines 4, 5 & 6 are done in one loop
Additional "Book-keeping"
Convert, for orientation purposes, intervals to length volume
Punch
CONTINUE 2

Block diagram for a heated pipe line computer program.

Additional Complexities. The Basic Elementary Case (BEC) can be extended to cover more complicated situations.

Multicrude Pumping Schedule. The most important complexity which can be built into the BEC concerns the analysis of a complete pumping schedule. In this case the computer does the following:

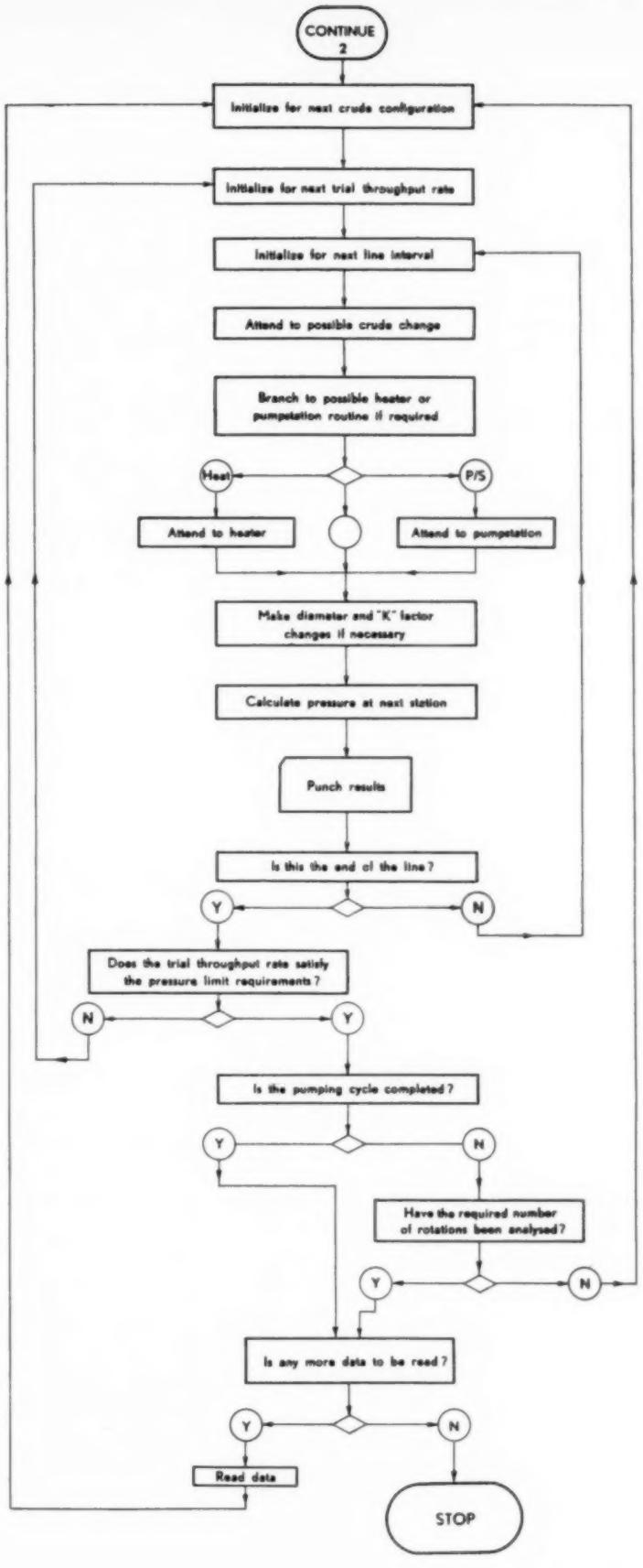
(a) It selects for itself an initial instantaneous line fill from the pumping schedule.

(b) It proceeds to analyze this state in the same way as in the BEC, paying due regard to changes in crude as it proceeds down the line. When it has derived an acceptable throughput rate it reports, in addition to the hydraulic details of the BEC, some relevant details of the crude interfaces. This information is intended to assist in assessing the extent of any crude mixing between adjacent batches.

(c) Instead of stopping (as in the BEC) the computer now proceeds to analyze a state of affairs occurring somewhat later in the pumping cycle. To work with a line fill corresponding to this new state of affairs, the computer "advances the fill," by moving the crude batches a given number of intervals down the line. It automatically drops any batches which have now left the line and introduces fresh batches, if necessary, at the input end.

(d) The computer analyzes and reports on this new line fill as described in (b).

(e) The operation of advancing the fill, analyzing the line and reporting the results, continues until either (i) the complete pumping cycle has been



analyzed or (ii) a predetermined number of line fills have been analyzed.

(f) The computer then reports the average thruput rate for the number of line fills examined, and stops.

The number of intervals by which the fill is to be advanced and the number of cases to be examined are at the discretion of the engineer. If a full pumping cycle is to be examined, the computer itself may be made to choose the number of times it will advance the fill.

Pipe line diameter changes are automatically incorporated in the calculations. Because of the need to advance the fill and keep track of the crude interfaces, in spite of diameter changes, the line is divided into intervals of equal volume. The computer calculates the lengths of these various intervals.

K-Factor Changes. Just as in the case of the diameters, the computer may be given changes in K-factor which it also incorporates in its calculation.

Multiple Heaters. Heaters may be situated at various points along the line. The computer takes note of each in turn and calculates the temperature rise and pressure drop. The maximum temperature limitations are always checked.

Multiple Pump Stations. Multiple pump stations, each with its limiting suction and discharge pressures, can also be handled by the computer. In this case, the computer calculates the BEC making suitable pressure increases at the pump stations.

If the limiting suction pressure requirements at each station are met, the computer proceeds as in the BEC. If minimum suction is violated, the the computer does the BEC only up to the first offending pump station and derives a thruput rate which satisfies these particular suction-pressures. Thus it establishes an overriding maximum thruput which may not be exceeded. Should a further suction-pressure requirement be violated, the computer again determines a further, and necessarily smaller, overriding maximum thruput. If the calculated output pressure at the end of the line is lower than the required value, the computer does the BEC for the entire line, because in such a case the intermediate suction-pressure requirements are not critical. However if the calculated output pressure is greater than the specified value, the intermediate-pressure restrictions do limit the thruput of the line and the previously calculated maximum thruput rate satisfying an "offending" pump station cannot be exceeded. The iteration is therefore completed.

Additional Pressure Restrictions. For the computer, pressure limits in sags and on hills etc. are established as "phantom" pump stations which give no pressure changes but have

TABLE 1—Summary of Equations Used by Computer for Calculation of Hydraulic Characteristics

To Calculate:	*General Form. of Equation
Reynold's Number	$R_E = \frac{2214 \times Q_H}{D_i \times \mu}$
Viscosity	$\mu = -.8 + e^{(CT)^n}$
Pressure Drop	(1)
(i) streamline flow	$\frac{dp}{dx} = \frac{120.9 \times S \times Q_H \times \mu}{D_i^4}$
(ii) transient flow	(1) $\frac{dp}{dx} = \frac{0.01234 \times S \times Q_H}{D_i^6 \times \mu}$
(iii) turbulent flow	(1) $\frac{dp}{dx} = \frac{5.68 \times S \times Q_H^{1.75} \times \mu^{0.25}}{D_i^{4.75}}$
"k" factor After the thermal conductivity of the ground has been determined in practice, the effective heat loss of the pipe, i.e. the "K" factor, must be determined	(2) $K = \frac{0.869\ k}{D_{of} \log_{10}\left[\frac{2H + \sqrt{4H^2 - D_{of}^2}}{D_{of}}\right]}$ Note: This calculation is not performed by the computer since the values of the "K" are part of the input data.

* The equations are quoted in their more common forms and not necessarily in the form used by the computer.

Cooling rate (i) In the case of turbulent flow the "K" factor as determined above applies and $K_R = K$	$t_2 = t_{amb} + \frac{t_1 - t_{amb}}{e^{\left[\frac{8.78\ L\ D_o\ K_R}{S\ Q_H\ \Theta}\right]}}$
(ii) In transient flow further insulation is provided by the additional laminar layer present and the "K" factor must be modified	Heat transfer of skin layer in transient flow h_t is given by (3) $\left[\frac{h_t}{\theta G}\right]\left[\frac{\theta \mu'}{k_L}\right]^{\frac{2}{3}}\left[\frac{\mu_o}{\mu_L}\right]^{0.14} \Big/ \left[1 + \left(\frac{D_i}{L_i}\right)^{\frac{2}{3}}\right] = \frac{0.116\ (R_E)^{\frac{2}{3}} - 125}{R_E}$
(iii) In streamline flow still greater insulation is provided by the laminar layers and a modification as above is necessary.	Heat transfer of the skin layer in streamline flow h_{st} is given by (3) $h_{st} = 1.86 \frac{k_L}{D_i}\left[\frac{4\ w\ \Theta}{\lambda L_L\ L_i}\right]^{\frac{1}{3}}\left[\frac{\mu_L}{\mu_s}\right]^{0.14}$
K_R as used to calculate the cooling rate is then given by	$\frac{1}{K_R} = \frac{1}{K} + \frac{1}{h_t}$ or $\frac{1}{K_R} = \frac{1}{K} + \frac{1}{h_{st}}$ Note that the engineer has to calculate K. The computer, however, calculates K_R.
Average thruput rate of pumping cycle	$\frac{1}{Q_{AVE}} = \frac{1}{Q_i} + \frac{1}{Q_{ii}} + \frac{1}{Q_{iii}} + \ldots\ldots$

NOMENCLATURE

C, n = constants defining viscosity of liquid (dimensionless)
D_i, D_o = inside and outside pipe diameters (units defined by subscripts)
G = mass flow rate, lb/hr-sq ft.
H = depth of burial to center line pipe, ft.
K = over-all heat-transfer coefficient, Btu/hr-sq ft-deg F.
L = length of interval, miles.
Q = thruput rate (units defined by subscripts).
R_E = reynolds number.
S = specific gravity (water = 1).
T = temperature in deg R.
h = heat transfer of skin layer, Btu/hr-sq ft-deg F.
k = thermal conductivity, Btu/hr-sq ft-deg F—ft.
dp/dx = pressure gradient, psi/mile.
Θ = specific heat of liquid, Btu/lb ($\simeq 0.5$).
μ = viscosity, centistokes.
μ = viscosity, lb/hr-ft.
t = temperature, deg F.
t_1, t_2 = initial and final temperature, deg F.
μ_1, μ_2 = viscosity of leading and trailing crude at interface, centistokes.

Subscripts

H = Bbl/hr.
D = Bbl/day.
i = inches.
f = feet.
s = refers to liquid at surface of pipe.
L = refers to bulk of liquid.
g = refers to ground (surrounding medium).
t = transient flow.
st = streamline flow.
R = resultant modified K-value.
(i), (ii), (iii), etc. = number of converged iterations in pumping cycle.

suction and discharge pressure restrictions.

DESCRIPTION OF PROGRAM

Initializing Phase. In the initializing phase of the program, the input as supplied is converted to a form usable by the computer for its subsequent calculations.

Discontinuities described earlier may occur anywhere along the line. The computer however makes small changes in the positions of the discontinuities to bring them into coincidence with the ends of intervals. This modified line, with which the computer actually works, is known as the *approximating line*. If the engineer considers that the accuracy of the approximation is inedequate, the number of equal volume intervals can be increased and the program restarted.

Error Routines. The chance of making an error in constructing data in accordance with precise rules is high. For this reason the computer checks the logical self-consistency of the input. Any logical errors, on certain program rules violations, e.g., a maximum limit to the number of pump stations, give rise to a so-called 777-error.

In addition to these errors, certain other conditions which the computer finds somewhat unusual are also reported with a special warning code known as a 555-warning.

In the case of a 555-warning, the computer assumes that the input, although unusual, is correct and continues. The 777-errors are different. Since they are the result of infringements of the basic rules, the computer normally stops after reporting them. However, it is possible to make the computer continue with the calculation even after it has reported a 777-error. But in the majority of cases, this will produce nonsensical answers.

Control Cards and Switches. There are numerous variations which can be induced by feeding special control cards to the computer, or by setting hand switches on the console. The switches are used to change the program while the computer is running; the cards are used when the change is to be made before the program starts.

The various possibilities are as follows:

Choice of Units. The program normally accepts and reports data in the following units:

(I) Viscosity.....Centistokes
(II) Temperature. deg F
(III) Batch volumes....U.S. barrels
(IV) Flow and pumping rates.....U.S. barrels per day
(V) Heater capacity...Btu per hr
(VI) Line diameter.Inches
(VII) K-factors....Btu/(sq ft-hr-deg F)
(VIII) Distance along line.....Miles
(IX) Pressure.....Pounds per square inch

The above units are normal. However, the computer contains the following provision to use other units:

(I) Viscosities are restricted to centistokes. No other units are available.

(II) Temperatures may only be in deg C or deg F. To operate in deg C a special control card must be fed to the computer.

(III) The remaining seven quantities may be in any units the engineer desires. To arrange for this only a single unit control card must be fed. However, the output from the computer is always in the same units as the original input.

Round-off of Output Data. The normal output from the computer in the so-called "floating-point" mode is somewhat tiresome to interpret. Accordingly the computer rounds off pressures, viscosities and distances to one decimal place, pumping rates and tender volumes to the nearest thousands (i.e., with three zeros). These may be changed by the use of a round-off control card.

Reynolds numbers and temperatures are both reported to the nearest whole number. Neither can be changed.

Restart Possibility. At the end of each iteration, the computer punches a "restart" card. If the program run is interrupted at any time, it can be made to continue from where it stopped, by reading in the original data together with the last restart-card punched.

Output Control. The computer should normally report only the full hydraulic details down the line when the iteration process of paragraph "Basic Elementary Case," has converged. For a number of reasons it may be desirable to study the convergence process. By setting a hand switch on the console the computer can be made to report full details of the line at every interval, for every trial thruput rate. Such information would be useful when using the program for design purposes.

The output from the computer can be either punched on cards or printed on line. This can be selected by a hand switch.

Compulsory Convergence. It may be desirable to discontinue the calculation pertaining to a particular line fill. A hand switch will do this. The computer will then stop what it is doing and advance the line fill without waiting for the iteration to converge. It should, however, be noted that in this event, the average thruput finally reported includes the trial thruput rate that was in use when the hand switch was set.

Multiple Solutions. It is a well-known fact that there are sometimes multiple solutions in the conventional type of heated pipe line problem handling very viscous crudes. The computer pays no regard to this possibility and it is impossible to say *a priori* which solution the computer will pick. In such a case it is up to the engineer to modify his input if he is not satisfied with the results.

Physical Changes. The simulation of an abrupt change in the system during a pumping cycle (e.g., changing the number of pumps in use at a particular pump station) is provided for. Only a restricted range of such variation is permitted. The computer is informed of such variations by an additional read at the end of its computation.

THREE KNOWN INACCURACIES

Apart from the inaccuracies inherent in the concept of the approximating line, there are numerous other inaccuracies which should be mentioned. Some of them are present because there is no adequately simple theory for avoiding them, some have not been eliminated because they are trivial and some should and would have been eliminated had there been any available room in the memory of the computer.

Pressure Drop Through Heaters. The presence of a heater results in a pressure drop. This is so much dependent on the construction of the heater than an accurate analysis of the pressure drop is prohibitive by the limited size of the computer's memory. The engineer must therefore provide the computer with reasonable average pressure-drop figures, corresponding to each crude in the system.

When the computer reaches a heater in its calculations, it simply reduces the line pressure by the predetermined amount corresponding to the particular crude that is in the heater at the time. It makes no correction for variations in thruput rate.

Pump Performance. To correct a standard pump-performance curve to compensate for the effect of the viscosity of the crude actually in the pump is too elaborate to build into this program. A simplification has therefore been adopted. For each crude the engineer derives a special correction factor, Q_F, which becomes part of the input data. The thruput of a pump station for a given pressure differential and a given crude is now Q_F times the thruput read off the standard curve of this pump station. In the authors' experience it is not difficult to derive an acceptably accurate Q_F-factor for the normal working range (but not for the extremes).

Average Thruput Rate. Whenever a crude interface moves through a pump station, relatively sudden changes occur in the thruput rate. These, the computer does not recognize until it deals with the next line-fill configuration. They are therefore ignored in the calculation of the average thruput rate. This effect should not be serious.

Transient Temperature Phenomena. Even if all crudes are heated to the same temperatures, the fluctuating flow rate would continuously create fresh time transients and prevent thermal equilibrium ever being reached. The computer makes no allowance for these transients and from the practical standpoint it is not necessary.

Cooling Rate. An attempt is being made to correct the cooling rate of the crude in transient and streamline flow. Only empirical equations are being used and conditions when these equations are not wholly valid could well arise. A precise solution is, however, not considered to be practical. At the time of preparing this paper, this correction had not yet been fully worked out, and it is not clear whether there will be sufficient memory capacity available on the drum finally to include it in the program.

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ACKNOWLEDGMENTS

The authors wish to thank the managements of Cia. Shell de Venezuela and the Bataafse Internationale Petroleum Maatschappij for permission to publish this article. They are also indebted to T. R. Young, John Green, and Shell Pipeline Corporation, Houston, for their valuable criticisms, to Pipeline Technologists, Inc., Houston, who provided some of the ideas which led to writing the initial program and to their good friend Fernando Rodriguez, late of IBM Caracas.

This article was condensed from a paper presented at the Petroleum Mechanical Engineering Conference of the American Society of Mechanical Engineers, New Orleans, Sept 18-21, 1960.

Computer Comes Up With Answers On Pipe Line Operations

Tapline finds out in advance what will happen if its marine terminal is tied up by storms, if stations should fail, etc.

By Donald W. Dreier
Supervisor of Operations
Trans-Arabian Pipe Line Co.
New York
and Brice A. Sachs, Senior
Engineer, Esso Research and
Engineering Co., Madison, N.J.

BACK IN 1958 the Trans-Arabian Pipe Line Company system reached a capacity of 460,000 barrels of crude per day and engineers decided it would be well to make a computer study of the system and its marine terminal. Esso Research and Engineering Company was asked to provide technical assistance in developing the program. The study was set up and began in January 1959.

Tapline's Facilities and Operations. The simulation model set up in the computer includes the following physical facilities which comprise the Tapline system:

- The 754 miles of 30 and 31-inch line located as shown on the map. It is divided into four sections, each operated in effect as a separate line. About half the line is above ground. This produces a 50° F daily swing in oil temperatures.
- There are four main stations: those at Qaisumah, Rafha and Badanah are diesel-powered; the one at Turaif has two 5,000-hp gas turbine drives.
- The system has four auxiliary pump stations spaced alternately with the main stations. With the exception of Qaryatain these stations are unmanned and remotely controlled by the upstream stations.

The turbines are subject to cyclic degeneration of efficiency because of wear and fouling. This causes a gradual loss of horsepower between cleaning and repairs. With these auxiliary units on stream flow exceeds 500,000 bpd; without them it is about 340,000 bpd. Unscheduled breakdowns have a major effect on throughput.

- Rafha, Badanah and Turaif stations each have a total of 276,000 bbls storage capacity which serves as a buffer between sections, preventing short-term variations in flow from affecting adjoining sections.
- Sidon Terminal has 20 tanks with a working capacity of 3,100,000 barrels.
- Sidon has five tanker-loading berths; four accommodate tankers of 40,000 dwt or less; the other can accommodate any tanker in existence. Oil is loaded by gravity, and the average for all berths during 1960 to date is about 25,000 bph. Peak rates in excess of 45,000 bph have been attained.

Operating policies descriptive of those presently governing the pipe line operation are included in the model. The major principle—the economic movement westward of the greatest possible quantity of oil over the long term. Decisions are generally made with an eye towards prevention of any unnecessary restriction of flow in the bottleneck section of the line. To this end, oil inventories in system tankage is regulated and maintenance is carefully scheduled.

Two types of economic losses occur despite such controls:

- Ship delays caused by storms, insufficient berths, or insufficient crude

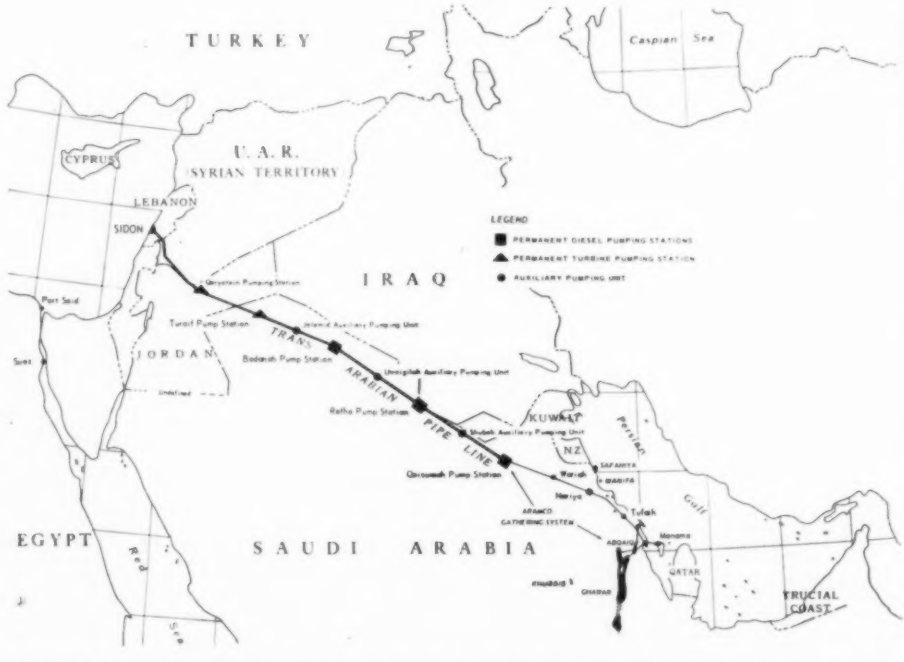


FIGURE 1—Map of the Trans-Arabian Pipe Line System. Flow is from right to left. The biggest factors affecting operations are: 1. Arrival of ships at Sidon, 2. Distribution of turbine downtimes, and 3. Frequency and duration of storms at Sidon.

on hand for immediate loading at maximum rate.

• Thruput losses due to reduced pumping because of high inventories downstream caused by prolonged storms at Sidon, a period of minimum liftings, mechanical failure of a pumping unit. An economic value can be assigned to such lost thruput.

Description of Model. The simulation model of the pipe line and terminal is largely deterministic in nature. Only two elements have been represented stochastically. The occurrence of ship arrivals and turbine breakdowns are represented probabilistically. All other parts of the model are based upon engineering calculations or upon decision rules used in the Tapline operations. The minimizing of stochastic elements in the model was done to reduce case-to-case variations due to chance. Representative simulations can thus be obtained with a relatively short computer run.

The model consists of a master routine, referred to as the "monitor program," and several subroutines which represent various phases of the operation. Basically these subroutines can be divided into three groups:

1. Routines for generating ship arrivals and the berthing and loading of such ships.

2. Routines for the calculation of flow rates in the pipeline.

3. Routines for accumulating thruput, and updating inventories.

The monitor program controls the entire sequence in the computer model. It calls in the subroutines for data as required, processes these data in accordance with pipe line and terminal operating logic, and prints out resulting information on flow rates, ship delays, inventories, cutbacks in thruput, accumulated thruput, and changes in turbine status.

Demand is placed upon the system by the "ship berthing and arrival generator section" that produces a ship-arrival pattern which approximates previous experience and moves the ships into berths in accordance with operating rules. Provision is made for variation in the sizes of ships loaded, changes in demand for oil, storms, number of berths, restrictions on loading of very large ships, availability of bunkers, and variations between the loading rates at various berths.

It became apparent early that the model results would be sensitive to the pattern of ship arrivals. Different arrival sequences produce significant differences in total ship delays. Therefore, generation of ship-arrival times, and the corresponding lifts, were made a separate computer program. This permits the use of the same arrival pattern in several case studies.

The method involves the use of random numbers and statistical distributions. Ship arrivals at Sidon were not significantly different, in a statistical sense, from a negative exponential distribution having the same average time between arrivals. Individual arrival times are generated by random sampling from the negative exponential distribution.

Statistical methods were used to insure that the cumulative numbers of generated arrivals over specific time periods were within control limits calculated from actual Sidon arrival data.

Random sampling of a distribution relating expected frequency of occurrence versus barrels lifted per ship was used to generate the size of ship cargoes. The distribution used in cases run thus far was derived from 1958 Sidon data by grouping all liftings into seven classes. The values for these classes as well as the expected number of arrivals and control limits on arrivals, may be varied as input data from case to case.

The ship berthing section uses the arrival and cargo-size information from the arrival generator in determining when each cargo would have been removed from Sidon inventory and what delays to ships would have been incurred.

The input to the model provides for assigning a "berth holding interval" for each ship size class at each berth. The berth holding interval is the time that a berth is not available for other assignment while a tanker is being loaded. "Very large" tankers are given a priority and are assigned to berths capable of accommodating them. Otherwise, tankers are preferentially berthed in order of ship size to allow the earliest completion of loading. The largest tankers are placed in the most efficient berths, but only until delays are encountered.

When a ship cannot be berthed upon arrival because of conflicts with larger ships in all available berths, all ships other than the very large tankers are rescheduled to a berth in order of arrival until the congestion is relieved, thereby preserving the "first come, first served" policy required by Tapline's contractual arrangements.

The period between the arrival and the time a berth becomes available is recorded as a delay due to lack of berths.

If sufficient oil is not available in tankage by the time the ship would normally have completed loading, the ship departure is delayed until a full cargo is available. The delay is recorded as being due to "inventory."

Weather data from Sidon records are used to determine port closures. Ships arriving during the closure are delayed and the delays are recorded as being due to storms.

Flow-Calculate Subroutine. Oil to satisfy the demand produced by ship arrivals is made available at Sidon in the quantities determined in the flow calculation subroutine. Flow rates in each of the four sections of line are calculated every six hours and whenever a turbine-powered unit is shut off or started. These flow rates are used in determining oil availability at Sidon and at main pump-station tankage.

The second stochastic element in the model exercises its effect in this subroutine. It has been assumed that the main pump stations will, because of adequate horsepower and multiple pumping units, be able to hold the maximum allowable discharge pressure. However, a turbine unit which goes off the line causes a major variation in flow.

Shutdowns of turbine units are the result of mechanical failure, scheduled maintenance, and excessive inventories in downstream tankage.

Mechanical failure of turbines, because of its unpredictable timing, has been represented stochastically. The time of occurrence of mechanical failure, its duration, and the turbine affected are determined by random sampling from probability distributions supplied as input data.

Profiles of turbine-horsepower degeneration due to fouling and wear are included as input data for each turbine, and are used to determine the horsepower for calculation of flow rates. Provision is made for periodic maintenance shutdowns of different durations.

Flow in the pipe line is affected by the specific gravity and viscosity of the oil. These are functions of oil temperature and API gravity, which can be determined from relationships supplied as input data. Ambient air temperature, which can also be cal-

culated from input data, affects the horsepower available from turbine-powered pumps, and must also be used in flow determinations.

Flowing oil temperatures and air temperatures are based on historical data. Normal temperatures for each section on each day are determined by interpolation along a rising trend line from the coldest part of the winter to the hottest summer days, and along a descending trend line for the other half of the year. Variations about the normal temperature for the day for each six-hour period have been determined by analysis of temperature recordings. Four patterns of variation about the norm have been provided—one for each season of the year.

Reproduction of the traditional pattern of pumping oil of lower API gravity during hot weather and higher API gravity during cold weather is incorporated in the model. Trend lines, similar to those used in normal temperature determinations are established, ranging between input variables for the highest API gravity to be pumped in winter to the lowest to be pumped in summer. Interpolation along these lines provides the gravity of the oil to be pumped.

Formulas for Arab Zone crude-oil viscosity, specific gravity and volume corrections for temperature are used in the model to avoid the use of tables. A formula was also derived for the Reynolds number-friction factor curve applicable to Tapline. Substitution of this formula in the accepted formula for flow in Tapline's 31-inch-diameter pipe provides a second formula for explicit solution for flow. This eliminates the usual trial-and-error method.

$$\log_{10} Q = -12.30075 + \log V + (18.67929 \log h - 37.35848 \log V + 305.02337)^{1/2} \quad (1)$$

where

Q = flow in barrels per day measured at flowing temperature
V = oil viscosity in centistokes at flowing temperature
h = hydraulic gradient in feet per kilometer

An explicit solution is possible only when h can be determined. For Tapline this is possible only when an auxiliary pumping unit in a pipe line section is not in operation and the corresponding main station is discharging oil into the line at a known pressure.

Methods of Flow Calculations. A second method is used to calculate flow whenever there is a discrete horsepower input to a section of the pipe line in addition to a pressure from the main station. This input will produce a pressure head (in addition to the main station pressure) varying inversely as the flow to which the power is applied. This case exists on Tapline whenever an auxiliary pumping unit (APU) is operated or when the Turaif turbines produce insufficient horsepower to hold maximum pressure.

The solution depends upon the simultaneous solution of equations for flow and for energy input and dissipation. In each section of line, a base station adds energy to the system by holding a particular discharge pressure. The second source of energy is the auxiliary pumping unit which adds a certain hydraulic horsepower, depending upon the ambient temperature and the condition of the turbine.

The two sources of power input and energy consumption can be equated, producing an equation in two unknowns, Q and h. These same unknowns are also found in the Tapline flow equation. The two can be solved simultaneously to determine flow through the section using the trial-and-error type of solution.

As a part of the flow solution, checks are made of certain critical areas of operation, and discharge pressures and horsepower input at APUs adjusted accordingly. Checks are made for:

1. Adherence to limits on discharge and suction pressures at the APUs. After correcting for the "arch gradient effect," due to temperature changes, the pressures are compared with the allowable pressures. If either limit is exceeded, the horsepower is reduced sufficiently to satisfy both limits. Flow is then recalculated.

2. Adherence to limits on allowable main station discharge pressures based on oil temperature, limits on combined stress in the pipe, and on APU suction pressure, because of surge pressure considerations. Both of these factors are considered, an appropriate main station discharge pressure selected, and a comparison made with the pressure used for calcuation of flow. Flow is then recalculated, if necessary, using the new pressure.

Inventories at Main Pumping Stations. After flow rates have been determined, they are used in the third group of subroutines. These rates are translated into thruputs which are used to update inventories at the main pumping stations. Different inventory control ranges are used upstream and downstream from the bottleneck section to protect flow in that section.

If an inventory violates either control limits, flow in the section is reduced retroactively, the inventory adjusted, and the amount of the theoretical flow reduction recorded.

After the final adjustments to flow have been made to keep station oil inventories within applicable limits, flow in the Turaif-Sidon section is added to the Sidon inventory. If the Sidon inventory exceeds a specified upper control limit, flow through the last pipe line section is reduced or stopped. In contrast to the procedure used in regulating pump station inventories however, no retroactive action is taken to return Sidon inventories to within the proper level. The quantity of tankage available and flexibility of the actual operation makes such a correction unrealistic.

Finally, cargo liftings during the period being considered are subtracted from Sidon inventory and there is a printout of key information. A printout is made whenever a turbine goes on or off or a ship is delayed. The printout includes the time and type of event causing the printout, the status of all turbines, flow rates, accumulated thruput into Sidon, inventories, and the cause and extent of delays to tankers.

Discussion of Case Studies Carried Out Using The Model. Several case studies have been run. The first group of five cases, was run for levels of ship liftings ranging from 425 to 470 mbd, with all other factors held constant, in order to find an optimum level of liftings.

The Tapline system capacity of oil varies between certain limits, with the amount of demand placed upon the system at Sidon. As the demand increases, ship delays also increase. The optimum level for scheduling ship liftings at Sidon is the point where the value of incremental system capacity is equal to the value of the increased ship waiting hours.

Fig. 2 shows the response of the system to various demands placed upon it.

As the level of liftings at Sidon is decreased below 450 mbd, the average

delay per ship slowly decreases. The delays below 450 mbd are caused largely by storms and by berthing delays resulting from the accumulation of ships during storms. Such delays are affected primarily by storm patterns and only secondarily by a reduction in demand on the terminal. As the level of liftings is increased above 450 mbd, ship delays resulting from a lack of oil and, to a lesser extent, from lack of berths, increase very rapidly.

The optimum scheduling point for the 1958 Tapline system where the values of incremental thruput and incremental ship delays are equal, was about 470 mbd as shown in Fig. 2. For purposes of comparison, ship delays for February and March of 1959 when liftings averaged 442 mbd are plotted. This period is too short to provide a good indication of the validity of the results of the computer runs, but the results are in general agreement.

To demonstrate use of the model in evaluating the desirability of making investments in facilities, a series of computer runs at different demand levels was made under base case conditions, except that energy input from each turbine was increased by 1,000 hp. The curve of ship delays verses liftings at Sidon obtained from these runs is shown in Fig. 3. As was done for the base-case curve, a point of optimum ship scheduling was selected on the new curve when the value of increasing liftings was balanced by the value of incremental ship delays.

The incentive for installing 1,000 additional horsepower at each turbine location can be measured by the value of the increased liftings and by the value of the reduction in delays to ships. The increase in liftings over the base case which can be economically made at Sidon is 5,000 bpd, over 1,800,000 bpy, and the decrease in delays to ships totals almost 2,200 hours per year. A value, depending upon prevailing tanker charter rates and the increased value of oil at Sidon can be placed upon these improvements, and weighed against the cost of the change in facilities.

Examination of this new curve of ship delays versus liftings indicates that restraints on liftings other than pumping horsepower have taken effect. For example, as indicated by the dotted line in Figure 3, the introduction of 1,000 extra horsepower at each turbine location should increase flow through the pipe line by about 14,000 bpd. If the hydraulic limits of the pipe are considered, however, it will be noted that all of the extra horsepower is not usable at all times. A gain of about 12,000 bpd would result if only the stress limitations on the pipe restricted use of the added horsepower. The detection and analysis of other restraints in the system are of major importance. The printout in this particular case indicates that either tankage or turbine-breakdown patterns, or a combination of both, limit the effect of the horsepower improvement.

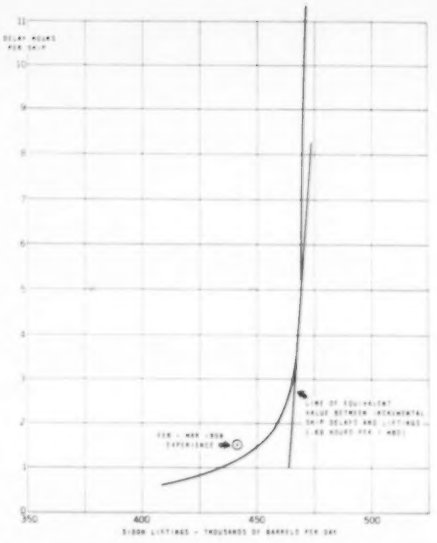


FIGURE 2—BASE CASE: The 1958 Tapline system (with 1960 estimated turbine reliability) 1958 storms and 1958 average ship size and size distribution.

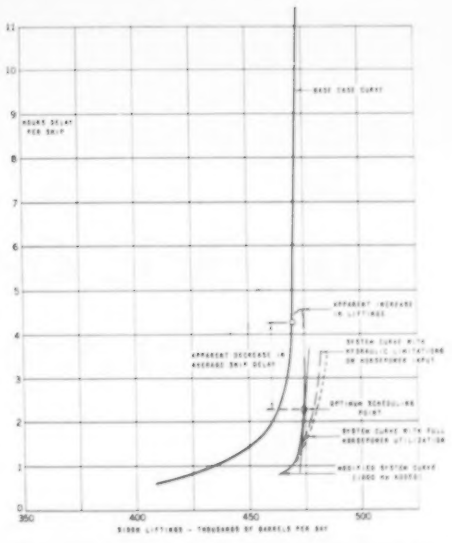


FIGURE 3 — ILLUSTRATIVE CASE: What happens when 1000 hp is added at each intermediate pumping location.

Conclusion. Results thus far indicate that the simulation model realistically represents the actual system. The model is extremely sensitive (as is the real system) to:

1. Number, size, pattern of ship arrivals.

2. Distribution of turbine downtimes.

3. Frequency and duration of storms at Sidon.

Careful analysis is required to assure that the input data for the model, which include the foregoing factors, completely and accurately describe the situation to be evaluated.

Complete analysis of the detailed printout of information is required to obtain the maximum benefits from each case.

Provided that the foregoing conditions are met, the model should provide better information upon which to make decisions about changes of facilities or operating policies.

ACKNOWLEDGMENT

From a paper presented at the American Society of Mechanical Engineers, Petroleum Mechanical Engineering Conference in New Orleans, Sept. 18-21, 1960.

About the Authors

Dreier

Sachs

Donald W. Dreier is supervisor of operations and engineering of Trans-Arabian Pipe Line Company. He is a graduate of the U. S. Military Academy at West Point and he received his M.S. degree from the University of Pittsburgh. He was in the U. S. Army Quartermaster Corps where he served as petroleum supply officer. Later he was with National Bulk Carriers, Inc.

Brice A. Sachs is senior engineer in operations and research at Esso Research and Engineering. He was graduated from Stevens Institute of Technology in 1951. At Esso he has specialized in operations research techniques, primarily as concerned with simulation and inventory controls.

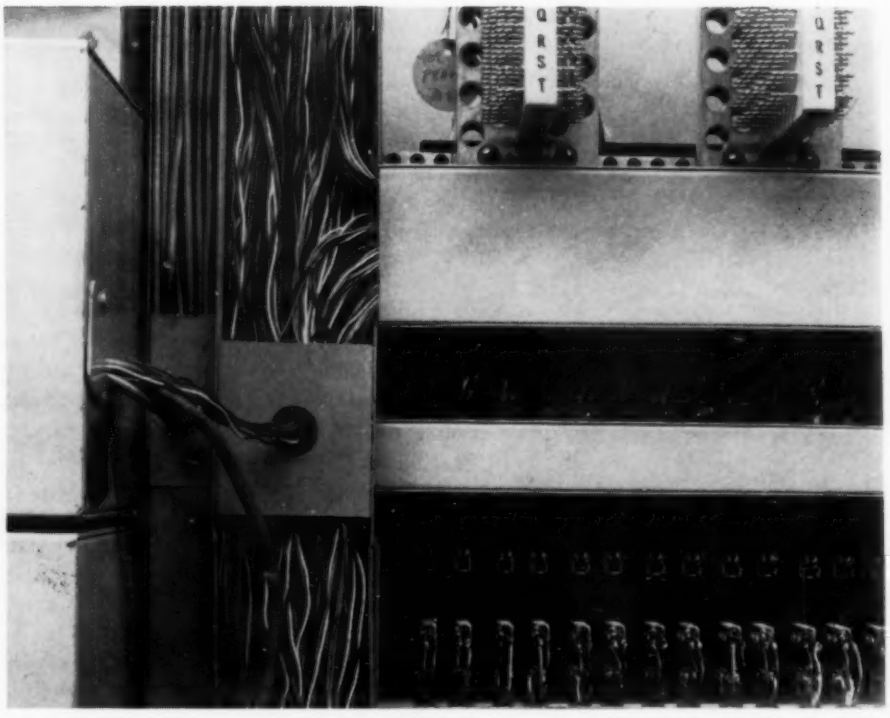
"Money Saving Idea for Communications"

Wire Mold On Communications Rack Saves Installation and Maintenance Time

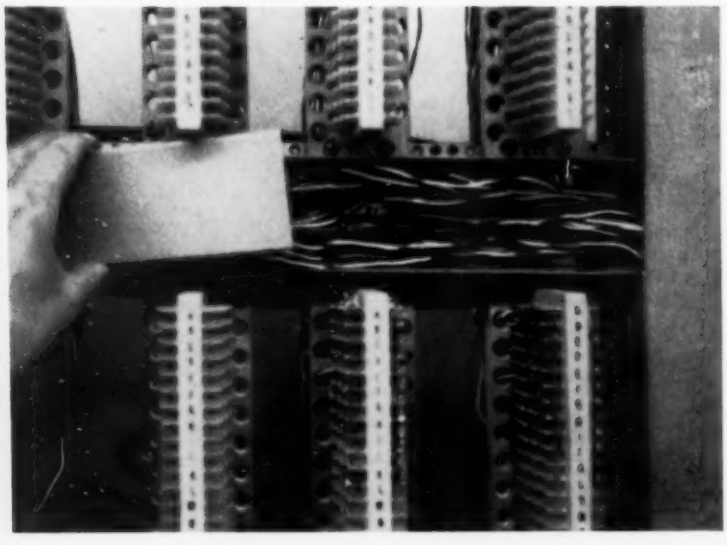
By installing wire molds on the back of communications racks in the place of lacing cables, El Paso Natural Gas Company simplifies both installations and repairs.

On all communications installations of any size, El Paso installs one run of wire mold for communications wiring and another for AC power wiring. When proper planning and layout is used, says E. C. Ekola, communications superintendent, it is never necessary to unlace and replace cables for changes or additions.

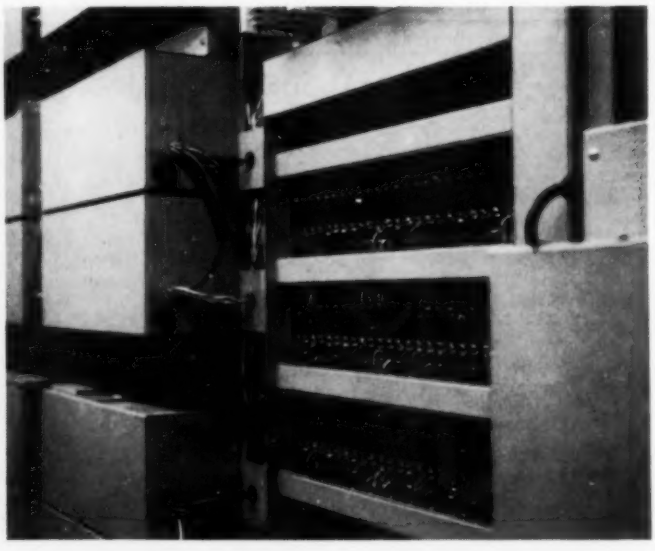
All that is required to add or delete wires is simply to remove the wire mold covers, make the required changes and snap the covers back on. This results in many manhours saved; and at the same time keeps a communications terminal neat and tidy.



Wire mold showing communications wiring center left and A. C. power supply wiring at left. This makes changes simple. Simply snap off mold covers, make changes and snap covers in place.



Wire mold feeding the terminal strips.



View showing jack strips which are fed from back of wire mold.

Pipe Line Pete's

IDEAS FOR THE FUTURE!

By **Donald M. Taylor,** Engineering Editor

A Plastic Cushion That's Cheaper Than Dirt

A plastic cushion used to cradle pipe lines over sharp-edged rock in blasted ditches is cheaper than bags of sand or dirt normally used for this purpose. This was vividly pointed out to the editors of PIPE LINE INDUSTRY the other day when colorful R. B. (Pipe) Bender, inventor of the new product, sallied into our offices just at closing time.

Tossing a couple of white blocks on a desk, he announced: "These are plastic cushion supports for pipe lines. They cost less than sand bags, weigh less than feathers and have a downright amazing strength! I'm betting they're gonna eliminate a lot of sand bags and backaches in the future."

I picked one up. He was right about one thing. If it had been any lighter it would have floated off like a balloon. "They look like stryo-foam Christmas tree ornaments—only they're slick," I said. "Can they really hold up a section of pipe line?"

"They're stronger than they look. Put one on the floor, stand on it and bounce." He shot a meaningful glance at my midriff. "Don't worry," he said opening a brochure. "They'll support an elephant. Here's a picture to prove it!"

Sure enough there was a picture of an elephant uncomfortably poised on two small white blocks.

"How do we know the elephant's real?" asked editor Mel Judah. "Maybe it's made out of plastic, too."

"You'll see," promised Pipe, tossing one of the blocks on the floor. "Stomp it!"

Our combined attack put nary a dent in the plastic, despite the fact that both Judah and I weigh as much as more pipe line than we care to mention. After winning this point, Pipe launched his sales pitch.

"This block is made up of thousands of tiny polystyrene cells molded together under heat and pressure. It has a compressive strength of 20 to 30 psi and you can glue it

right onto the pipe as you cradle into the ditch. Counting labor, these things are cheaper than skids. They'll save a contractor plenty of dough.—You convinced?"

"Yep! Just wish I had a pipe line to put some on."

This apparently satisfied Pipe. He loaded up his blocks and dashed out. Probably to "sell" our competitors too.

High Speed Print Out Tube Reproduces Photos, Typing

A new type tube, similar in many respects to a TV picture tube, can reproduce high-quality photographs in as little as ⅓ second. It will likely be used by newspapers and magazines to reproduce photographs; one magazine will use a tube to reproduce some two million addresses from tapes in an eight-hour day. Pipe line companies could use such a device to receive charts from the field and to write out checks, etc.

Here's the way it works: The flat-face tube has microscopic wires spaced 250 per inch extending through the glass, protruding slightly so as to contact the paper. The energy imparted by each of these wire brushes, determines whether or not a minute space on the paper will be black or white. Collectively, these dots will tote up to a high quality photograph.

Discoveries in Radar, Radiation, and Electronics

Cabbage Withstands Radiation

Guinea pigs that eat cabbage have lived through radiation exposures that killed non-cabbage-eating control animals. This is one of the findings of Stanford Research Institute scientists who are looking for dietary supplements that will protect humans from radiation. They point out that protection against atomic bomb exposure is not the only benefit that could come from such supplements. Cancer treatment could be advanced if humans could survive exposure to more intensive radiation treatments.

Fastest Camera Alive!

The world's fastest camera developed by Electro-Optical Systems, Inc., of Pasadena, Calif., for U.S. Army Ordnance is being used to photograph explosions at the moment of detonation at the Picatinny Arsenal in Dover, N. J. Intense light necessary for such high-speed photographs is supplied by setting off an argon light bomb at the moment of exposure.

Commutator for DC Machines

A transistorized, four-segment electric commutator capable of switching power loads up to 600 watts has been developed for the Air Force as part of a research program aimed at finding substitutes for mechanical commutators, according to an announcement of the U. S. Department of Commerce. A machine using this commutator was run as a d-c motor and generator at a power level of 240 watts. MIT classifies this phase of the experiment as successful but points out that more work on the solid-state switching devices will be necessary before the electronic commutator will be practical for high-power machines.

Instrument Detects Batch Changes

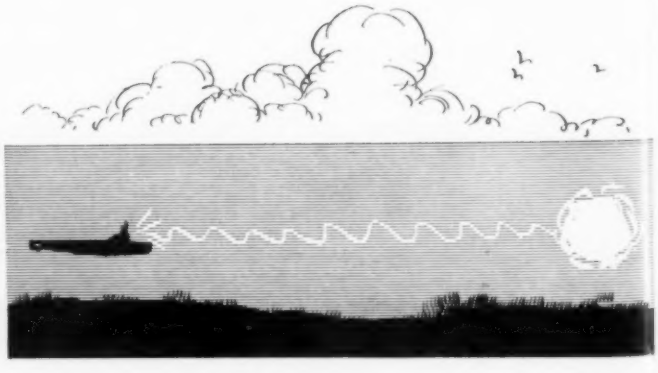
A new instrument that measures dynamic surface tension continuously may prove useful in detecting tender changes on products and crude lines. It records the force in surface layers of a liquid film passing through parallel rods 3/32 inches apart. Surface tension tends to pull the rods together, and fortunately this force is virtually independent of the film's thickness and width. The new device was developed by Whirlpool's E. C. Peterson and Albert R. Martin.

Radar Beams to Heat Underground Oil

Considering that oil is stored in the pores of rock, it's a wonder it ever flows. But as wells are pumped down, the temperature surrounding the bore hole drops and where the oil is viscous, this is often sufficient to slow production greatly. Petroleum engineers have long dreamed of an effective down-the-hole heater which can penetrate back into the formation. Raytheon engineers may have a solution to this problem. They are planning to use special electronic generators of high frequencies in the microwave regions. This will be similar to the radar range ovens now on the market.

Communications Under the Sea By Radio and Explosives

As the U.S. Navy finishes construction of a powerful radio transmitter, which can be heard by submarines under the sea, a Columbia University research group announced that they had recorded the sound from depth charges 12,000 miles distant. The charges were detonated off the coast of Australia and recorded 223 minutes later at Columbia's seismic station in Bermuda. The latter is the base for SOFAR (sound fixing and ranging system). The purpose is to enable ships or planes in distress to set off small depth charges to signal their position.



Fantastic Advances in Ceramics

Fired up by the opportunities in missiles and other high-temperature applications, three different groups of researchers have come up with remarkable advances in ceramics: Horizons, Inc., a Cleveland, Ohio, research organization has developed fiber reinforced alloys that have as much as 300,000-psi tensile strength at elevated temperatures. One such alloy is 80 percent nickel and 20 percent chromium. The reinforcing fibers are composed of aluminum oxide, sapphire or corundum in single crystal form.

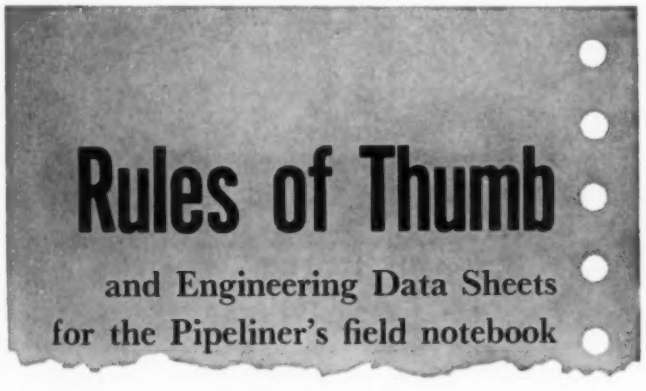
National Carbon Co. recently announced that recrystallized graphite has about three times the high temperature strength of conventional graphite. It will retain most of its strength at temperatures as high as 5,500 F.

Pfaudler Permutit filed patent applications on a ceramic made by bonding tiny crystals of a newly developed glass with metal alloys.

Powerful Magnet for 1964; New Electron Tube Developed

The new Massachusetts Institute of Technology Magnet Laboratory is expected to house the world's most powerful magnet when it is completed in 1964. The strength of the magnet is rated at 250,000 gauss—it will be used to study the behavior of atoms and atomic particles.

Westinghouse Electric Corp., has invented a light-amplifying tube which makes visible every individual elementary particle that triggers its ultra-sensitive output. It is more powerful than our larger telescopes.



$25 for Engineering Data Sheet $15 for Rule of Thumb

These practical aids give quick, reasonably accurate answers to design, maintenance and cost estimating problems. PIPE LINE INDUSTRY will pay $25 for each chart, nomograph or data sheet published—$15 for each Rule of Thumb. Send your ideas to PIPE LINE INDUSTRY, P. O. Box 2608, Houston, Texas

Miscellaneous

—42—How large should drums and sheaves be for various types of wire rope?

The diameter of sheaves or drums should preferably fall within the table* given below for most efficient utilization of the wire rope.

Type of Wire Rope	6 x 19	6 x 37	8 x 19	5 x 28	6 x 25	18 x 7	6 x 7
For best wear	45	27	31	36	45	51	72
Good practice	30	18	21	24	30	34	42
Critical	16	14	14	16	16	18	28

Example: What size should the hoisting drum on a dragline be, if the wire rope is 6 x 19 construction, ¾ inch in diameter?

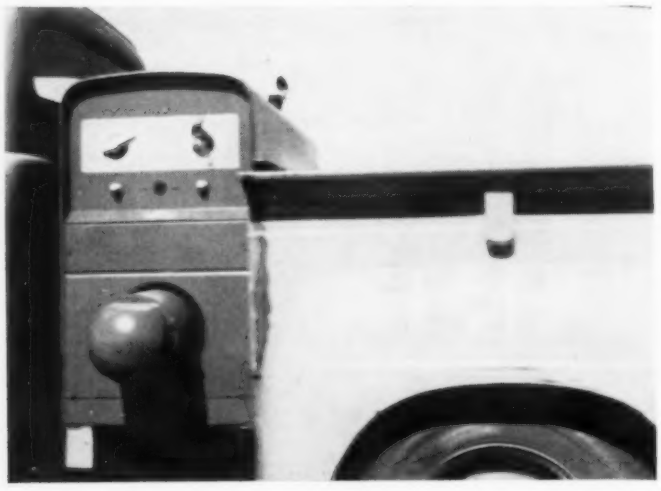
From the table, good practice calls for 30 diameters which in this instance would be 22½ inches. Loads, speeds, bends and service conditions will also affect the life of wire rope so it is better to stay somewhere between the "good practice" and "best wear" factors in the table.

* *Construction Methods and Machinery*, by F. H. Kellogg, Prentice-Hall, Inc., 1954.

How to do it

PIPE LINE HINTS

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, PIPE LINE INDUSTRY, P. O. Box 2608, Houston 1, Texas



How to Modify a Pickup Truck for a Utility Welder

Cut away part of a pickup truck bed, place a welding machine athwart the chassis and you will have a rig that will delight the heart of almost any utility welder.

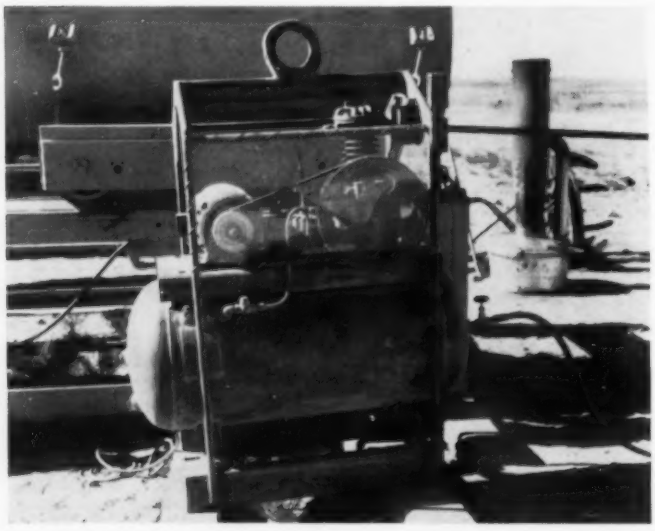
The welding machine bolts directly to the truck frame, but be sure to leave room for cranking the machine on the cranking end. Use plywood to bridge across the bed next to the machine. This helps retain the truck's usefulness as a means of hauling fittings, rods, etc., to the job; and, at the same time, keeps tools out of the engine.

Welders Keep Improving Rigs on the Firing Line

Visit almost any pipe line spread, take a look at the firing line welding machines. Chances are, you will find them riding a cart, trailer, sled or other means of transportation which will give evidence of a certain amount of ingenuity, thought and inventiveness.

The reason?

These trailers are thought up and constructed by welders who—next to payday—enjoy making things convenient for themselves and other welders. Take, for example, the firing-line rig shown here. Note the water can, the two lengths of pipe for beveling machines, welding leads, etc., and the husky tool box balanced right in the middle of the trailer. There's also a place for an umbrella and other labor-savers dear to the heart of the welder.



Air Receiver, Compressor and Motor Combined in Package

Mount the air-receiver on a steel skid, mount the air compressor and motor on top of the receiver and tie the entire unit together in a handy package for a side boom tractor or a gin-pole truck.

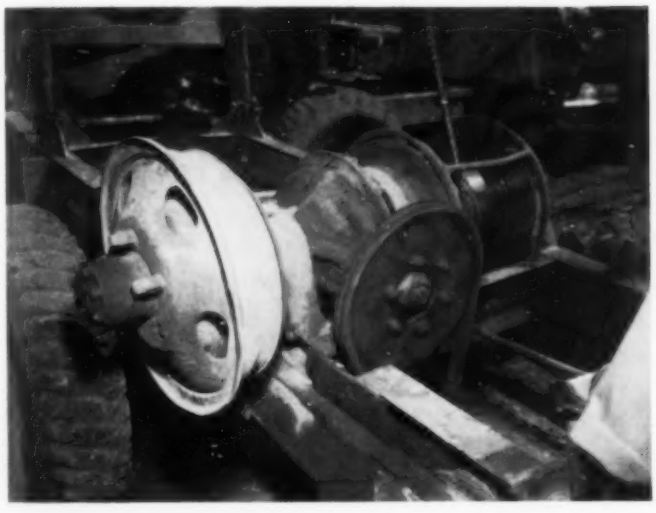
Note that the motor-compressor assembly has a screen wire guard to protect workmen.

The skids beneath the unit are made of channel iron, the frame is of one-inch pipe and the cross member at the top was cut from ½-inch steel plate.

Keep Track of Construction Equipment Fuel Consumption

Here's a diesel fuel trailer that can quickly service units and at the same time keep track of the number of gallons of diesel fuel that goes to individual pieces of construction equipment. One of the advantages of this is that the fuel bill is one of the heavy expenditures on any construction spread, and it should behoove any contractor to keep up with fuel consumption of individual units.

Power for the unit is supplied by a small lawn-mower-type motor; the meter is similar to those found in service stations.



Winch Mounted on Back of Gin Truck Proves Handy

Here's a temporary arrangement that can be used for unloading light pipe from gondolas at the rail sidings. The winch is mounted on back of a gin truck with a long "stinger" and operated through braking the wheel at the left. The winch drum is made of pipe and steel plate flanges, the drive to this "drawworks" comes to the differential via the belt and sheave shown.

When the truck wheel at left is braked, the drum at the right turns to take in line and lift the load. When the brake is released, the drum can free-wheel. To come down with the load, the truck clutch is used (it can be operated remotely).

In loading or unloading pipe, the operator uses the left hand lever to brake the wheel at the left. The foot pedal engages or disengages the clutch.

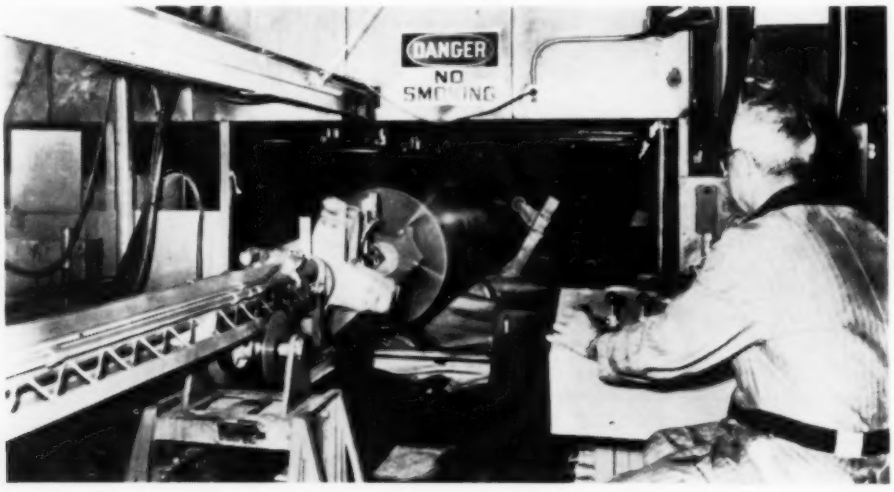
How to Get Better Welds Underneath Large Size Pipe

As a rule, men do their best work under favorable conditions. Welding the underside of large diameter pipe ordinarily requires that a welder gets in an uncomfortable and awkward position.

Here is one solution to positions involved in welding large pipe. From one-inch and half-inch pipe weld up a single frame as shown here. Make it hinge at the top, so it can be easily transported. Used in connection with a wooden pallet, it can provide support for the welder as he makes the under side weld. Used as steps, it will help him weld the top side.

WHAT'S HAPPENING IN PIPE LINE CONSTRUCTION

By Donald G. DePugh, Construction Editor



Internal Coating at the Mill

Facilities for internal coating of large diameter pipe at the mill have been installed at A. O. Smith's Milwaukee plant. The process includes scrubbing with cleaning solution, hot water flush rinsing, and electric induction heating to eliminate moisture before applying the coating. Pipe from 16 to 30 inches can be processed at the plant.

Contracts Let on Canada to California 1,400-Mile, 26-36-Inch Gas Pipe Line

Contracts have been awarded and construction on a small portion of the Alberta to California gas line will begin soon. The 1,400-mile, 26-36-inch line extending from near Edmonton, Alta, to near San Francisco, Calif. will be completed by winter of 1961.

The $330-million line will be owned and operated by four companies. Pacific Gas and Electric Company will build the 291-mile, 36-inch section in California; Pacific Gas Transmission Company will lay the 614-mile, 36-inch interstate line from the Canadian border to the California-Oregon border; Alberta Natural Gas Company will construct the 107-mile, 36-inch segment in British Columbia, and Alberta Gas Trunk Line Company, Limited will build 386 miles of 26, 30 and 36-inch pipe in Alberta.

Contractors for the Canadian section include Price-Poole of Canada, Ltd., which will lay the 107-mile section between the Alberta-British Columbia border and United States-British Columbia border. On the Alberta Gas Trunk Line project Majestic Contractors, Ltd., will build 113 miles from Crowsnest Pass to Priddis, Alta.; Mannix Co., Ltd., will lay 113 miles from Priddis to Rocky Mountain House, Alta.; Majestic Contractors has 63 miles from Rocky Mountain House to Cynthia, Alta.; Duttom-Williams Brothers, Ltd., will construct 62 miles from Cynthia to Whitecourt, Alta., and Piggott Construction Ltd., will build the 64-mile section of 16-inch from Crowsnest Pass to Carway, Alta.

Route of Canada-California Line

The Pacific Gas Transmission Company let contracts to H. C. Price Company for the 146-mile segment from Rosalia, Wash., to the Idaho-British Columbia border. The 486-mile portion from Calfornia-Oregon border to Rosalia, will be constructed by Western Pipeline, Inc., and J. P. Neill and Co., Inc., in a joint venture.

Pacific Gas and Electric has awarded contract to H. C. Price Company for the 291-miles from Oregon-California border to near San Francisco.

Clearing of the rights of way and preparation of road, railway, and river crossings will begin as soon as contractors can move in equipment. Pipe is being delivered to one welding and coating yard at Sprague River, Ore., and other deliveries will begin soon at Burney and Napa, Calif., and a number of other points in the Pacific Northwest.

The Bechtel Corporation has been retained as engineering manager for the Pacific Gas Transmission Company construction. Contracts will be awarded later for construction of compressor stations, maintenance bases and major river crossings along the route.

The project will include elevations from sea level to mile-high mountains, 14 major river crossings and other problems.

The line will deliver an average of 415 MMcf of gas daily to Pacific Gas and Electric for distribution in Northern and Central California. Along the route Pacific Gas Transmission will deliver additional gas to El Paso Natural Gas Company for distribution in the Pacific Northwest. Montana Power Company will import gas through a lateral from the facilities of Alberta Gas Trunk Line Company.

Mid-America Considers Chicago to Superior Line

Mid-America Pipe Line Co. is considering plans to construct a by-products line from the Chicago area to Superior, Wis. The 405-mile, 10-inch line would tie into Lakehead Pipe Line Co. which is connected to the Interprovincial Pipe Line of Canada.

Interprovincial would take byproducts from Alberta for delivery to Mid-America at Superior. The new system would cost $21 million.

Several proposals have been made in Alberta for gathering systems to take byproducts for delivery to the United States. Hearings are under way on plans of Westalta Products Pipe Line, Ltd., and Foothills Pipe Lines, Ltd. Westalta plans a 900-mile gathering system in Alberta to supply products to Foot Hills. The latter would lay a 1,300-mile line from the Alberta-Saskatchewan border to Chicago.

Hydrocarbons Pipeline, Ltd., and Provincial Pipeline, Ltd., have applied to the Alberta Oil and Gas Conservation Board to construct gathering system in Alberta for delivery to the Interprovincial system.

Oxygen-Nitrogen Pipe Line Planned by Linde Company

Plans have been announced by Linde Company, Division of Union Carbide Corporation, to lay an oxygen-nitrogen pipe line distribution system to serve various industries around the Ship Channel in Houston.

The line would originate from a new plant to be installed in that area, possibly at Deer Park, next year.

The first leg of the line is an 8-mile long oxygen supply line to supply 140 tons per day of high-purity oxygen to the Sheffield Division, Armco Steel Corporation, and 320 tons per day of high-purity oxygen plus 105 tons of high-purity nitrogen to Diamond Alkali Corporation.

Michigan-Wisconsin Lets Contract to R. H. Fulton

Michigan-Wisconsin Pipe Line Company has let a contract to R. H. Fulton & Company for construction of 9 miles of 6-inch and 17 miles of 8-inch pipe line near Manitowoc and Two Rivers, Wis.

TRANS-SOUTHERN PIPE LINE ROUTE

Trans-Southern Pipe Line Corporation Plans $63 Million, 1,080-Mile LPG Line

A major liquefied petroleum gas pipe line to carry LPG into the southeastern states has been proposeed by Trans-Southern Pipe Line Corporation, a subsidiary of Transcontinental Gas Pipe Line Corporation.

The line would extend 1,080 miles from Mont Belvieu, Texas, near Houston, to Danville, Va., with a 215-mile spur planned from Atlanta to the Georgia-Florida state line. The $63 million system will have a maximum diameter of 12 inches. It will be designed for an initial daily capacity of 60,000 barrels and is expected to be in operation by November 1961.

Underground storage terminals will be developed near Atlanta and Eunice, La. At Atlanta, caverns will be mined in the local granite substructure and will have a capacity of 1 million barrels. The underground storage in Eunice salt domes will have a 350,000 barrels capacity.

A 35-mile spur line from Laurel to Hattiesburg, Miss., and a 25-mile spur from Linden to Demopolis, Ala., will extend to existing privately owned storage facilties.

Trans-Southern would receive LPG for shipment near Mont Belvieu and Beaumont; near Lake Charles, Eunice and Baton Rouge in Louisiana.

Terminals will be located near Baton Rouge, Laurel, Linden, Roanoke, Ala., Atlanta, Greenville, S.C., Charlotte, N.C., Danville, Macon, Ga. and Waycross, Ga.

Market areas to be served will be in Louisiana, Alabama, Georgia, South Carolina, North Carolina, Virginia, Florida and Tennessee.

Glacier Pipe Line Formed To Lay Crude Line System

Continental Pipe Line Company has formed the Glacier Pipe Line Company to build a 433-mile crude pipe line system in Montana and Wyoming. The $13.5 million system would extend from Cut Bank, Mont., to Byron, Wyo., and will connect at Byron the Platte Pipe Line Co. and other lines to the St. Louis and Chicago areas.

Contract for construction of the line has been awarded to R. H. Fulton and Co.

From Roundup, Mont., a 55-mile spur line will extend to the northeast to connect oil fields in central Montana. The line will be 8 inches in diameter from Cut Bank to Roundup; 10 inches from Roundup to Billings, and 8 inches from Billings to Byron. The 55-mile spur will be 6 inches.

Calnev Pipe Line Co. Laying 225-Mile Line

Calnev Pipe Line Co. has awarded a contract to Williams Brothers Company to lay a 225-mile, 6-8-inch, products pipe line from Colton, Calif., to Las Vegas, Nev.

The $10 million project has been promoted by Union Pacific Railroad. It will transport about 16,000 to 18,000 barrels daily taking products from Southern Pacific Pipe Lines, Inc., at Colton.

PROPOSED PIPE LINE CONSTRUCTION

Here in convenient summary form is Pipe Line Industry's listing of company, line size, length, service, location and project status.

U.S.

Algonquin Gas Transmission Co., Boston, 25 miles, 20-inch; 8 miles, 8-inch, gas, and 12,000 hp addition in Massachusetts, $6 million, before FPC.

Arkansas Louisiana Gas Company, Shreveport, La., 58 miles, 2-6-inch, gas, planned.

Belle Fourche Pipeline Co., Casper, Wyo., 103 miles, 8-inch, crude, Fiddler Creek field to Lance Creek, Wyo., and branch lines from North Donkey Creek field to Rozet and Miller Creek fields, $2¾ million, approved by Wyoming Public Service Commission.

Border Gas Transmission Company, 300 to 400 miles, gas, gathering, in south Texas, $10 million, planned.

Buckeye Pipe Line Co., New York, 54 miles, 16-22-inch, crude, main lines from Toledo to Samaria, and Detroit, Mich., $4 million, contract let on 41 miles of 16- and 22-inch to **Panama Williams Corp.** and **Somerville Construction Co.**

Calnev Pipe Line Co., 225 miles, 6-8-inch, products, Colton, Calif., to Las Vegas, Nev., $10 million, contract let to **Williams Brothers Co.**

Carolina Pipeline Company, Columbia, S. C., 85 miles, 8-inch, gas, in South Carolina, $5 million, before FPC.

Coastal States Gas Producing Co., Corpus Christi, Texas, 60 miles, 10-inch, gas, gathering, La Salle and Frio counties, Texas, before FPC.

60 miles, small diameter, gas gathering line, to tie in with system under construction and extend to Pearsall County, Texas, planned.

25 miles, gas, Associated Gas & Oil Co. field to South-Tex Corp., processing plant west of Corpus Christi, Texas, planned.

37 miles, gas gathering in Brown, Eastland, Comanche and Erath counties, Texas, planned.

Coastal Transmission Corp., Houston, 81 miles, 3 to 10-inch, gas, laterals; 5,500 hp in stations at Port Lavaca, Texas, and Eunice, La., and additional 1,500 hp at Robstown, Texas, $6.2 million, before FPC.

Colorado Interstate Gas Co., Colorado Springs, 140 miles, 34-inch, gas, Green River, Wyo.,-to-Provo, Utah; 109 miles, 26-inch, Texas Panhandle to southeastern Colo., 136 miles, 34-inch, southeastern Colorado-to-Pueblo, Colo.; 107 miles, 30-inch, Pueblo-to-Denver, $91 million, FPC examiner approval.

Colorado Oil & Gas Corp., Denver, 400-miles, gas, from Gubik field to Fairbanks, Alaska, planned.

East Coast Pipeline Co., 90 miles, 12- to 24-inch, products, Linden, N. J. to Suffolk County, N. Y., $25 million, planned.

El Paso Gas Supply Company, El Paso, Texas, 228 miles, 30-inch, gas, main, Live Oak to Sutton County, Texas, $30 million, planned.

El Paso Natural Gas Company, El Paso, 199 miles, 30-inch, Permian-San Juan crossover loop, before FPC.

17 miles, from Pacific Gas Transmission Co. facilities to near Spokane, Wash., before FPC.

34 miles, 20-inch, Puckett to Goldsmith, before FPC.

23 miles, 20-inch, Goldsmith to Eunice-Plains line, before FPC.

9 miles, 20-inch, Goldsmith-Plains loop, before FPC.

43,600 hp in new and existing stations in Texas, Oklahoma, New Mexico and Utah, before FPC.

400 miles, 34-inch, Salt Lake City, Utah, to California border, FPC examiner approval.

El Paso Natural Gas Products Company and **El Paso Products Pipeline Co.,** 32 miles, 6-inch, crude, from Patrick Draw Oil and Gas Field to Wamsutter, Sweetwater County, Wyoming, before Public Service Commission.

Equitable Gas Company, Pittsburgh, Pa., 31 miles, 16-inch, and 26 miles, 20-inch, in West Virginia and Pennsylvania, $5 million, before FPC.

Glacier Pipe Line Co., Ponca City, Okla., 433 miles, 8-10-inch, crude, Cut Bank, Mont., to Byron, Wyo., $13.5 million, contract let to **R. H. Fulton and Company.**

Goliad Corp., Houston (Joint venture with **Union Oil Co. of Calif.**), 85 miles, LPG, Kaplan, La. to Baton Rouge, extraction plant at Kaplan and fractionation plant at Baton Rouge, $12 million, planned.

Great Northern Railway, St. Paul., 110 miles, crude, fields in Burke and Bottineau counties to Minot, N. D., $3½ million, contract let on 50 miles to **Curran and Company.**

Hope Natural Gas Company, Clarksburg, W. Va., 20 miles, 20-inch, gas, in Lewis, Ritchie and Pleasants counties, W. Va., $2 million, FPC authorization.

Houston Texas Gas & Oil Corp., St. Petersburg, Fla., 199 miles, 2 to 6-inch, gas, laterals; 20,000 hp in five new stations; $12 million, before FPC.

Iron Ranges Natural Gas Co., 115 miles, gas, from Itasca and St. Louis counties along route of Mesabi range from Grand Rapids to Aurora, Minn., $5 million, FPC authorization.

60 miles from Duluth to Silver Bay, Minn., FPC authorization.

Kansas-Nebraska Natural Gas Company Hastings, Neb., 165 miles, 2-8-inch gas, extension from Alliance, Neb., to Chadron, Crawford, Hemingford, Hay Springs, Gordon and Rushville, Neb. before FPC.

45 miles, 2-3-inch, gas, in Kansas approved by Kansas Corporation Commission.

2,000 hp addition at Scott City, Kan. FPC approval authorization.

2,500 hp addition at Holcomb, Kan. before FPC.

Lo-Vaca Gathering Co., 230 miles, 6-20 inch, gas, gathering, Live Oak to Lavaca County, Texas, planned.

Manufacturers Light and Heat Company, Pittsburgh, 103 miles, 20-inch, gas, in Franklin, Adams, Fayette, Green, Fulton and Somerset counties, Pa., $7 million, contract let on 70 miles to Williams Bros. Co.

Matador Pipe Line Corp., Denver, 175 miles, crude, from Bottineau, Burke and Renville counties, N. D., to Cromer, Man., Canada, $4 million, proposed.

Michigan Wisconsin Pipe Line Co., Detroit.

37 miles, 6 and 12-inch lateral loops in Wisconsin, before FPC.

29 miles, 30-inch, loops, Illinois, Indiana, and Michigan, 3,000 hp. station, Janesville, Wis., before FPC.

Two 2,000 hp units at Meade, Kansas; one 2,000 hp unit at Havensville, Kansas, before FPC.

Mid-America Pipe Line Co., 405 miles, 10-inch, LPG, Superior, Wis., to Chicago, $12 million, planned.

Mississippi River Fuel Corp., St. Louis, 20 miles, 12-inch, 3 miles, 4-inch, gas, 2,500 hp station, to develop underground storage reservoir at St. Jacobs field in Madison and St. Clair counties, Ill., $3 million. Before FPC.

Mississippi River Transmission Corp., (subsidiary Mississippi River Fuel), 115 miles, 18-inch, gas, southeast Missouri to St. Louis County, planned.

Natural Gas Gathering Co., Inc., (joint venture with Gulf Resources, Inc.) gas gathering facilities in Zapata and Starr counties Texas, before FPC.

Natural Gas Pipeline Company, Chicago, 62 miles, gas, pipe line and various river crossings, before FPC.

New Haven Pipeline, Inc., products line, New Haven, Conn. to Springfield, Mass., $2.5 million, planned.

Niagara Mohawk Power Corp., 122 miles, 12-inch, Watertown and Massena, N. Y., contract let to Fulghum Contracting Corporation pending FPC approval.

Northern Natural Gas Company, Omaha, Neb., 236 miles, gas, in Kansas, Nebraska, Iowa, Illinois and Wisconsin, and 14,050 hp, $25 million, before FPC.

124 miles, in Oklahoma, Kansas, Nebraska, Iowa, and Minnesota and 17,360 hp, $17 million, before FPC.

22 miles, in Iowa, $673,100, before FPC.

Northwestern Refining Co., crude gathering system, Rival and Lignite fields, North Dakota, $625,000, Public Service Commission approval.

Continued on Page 76

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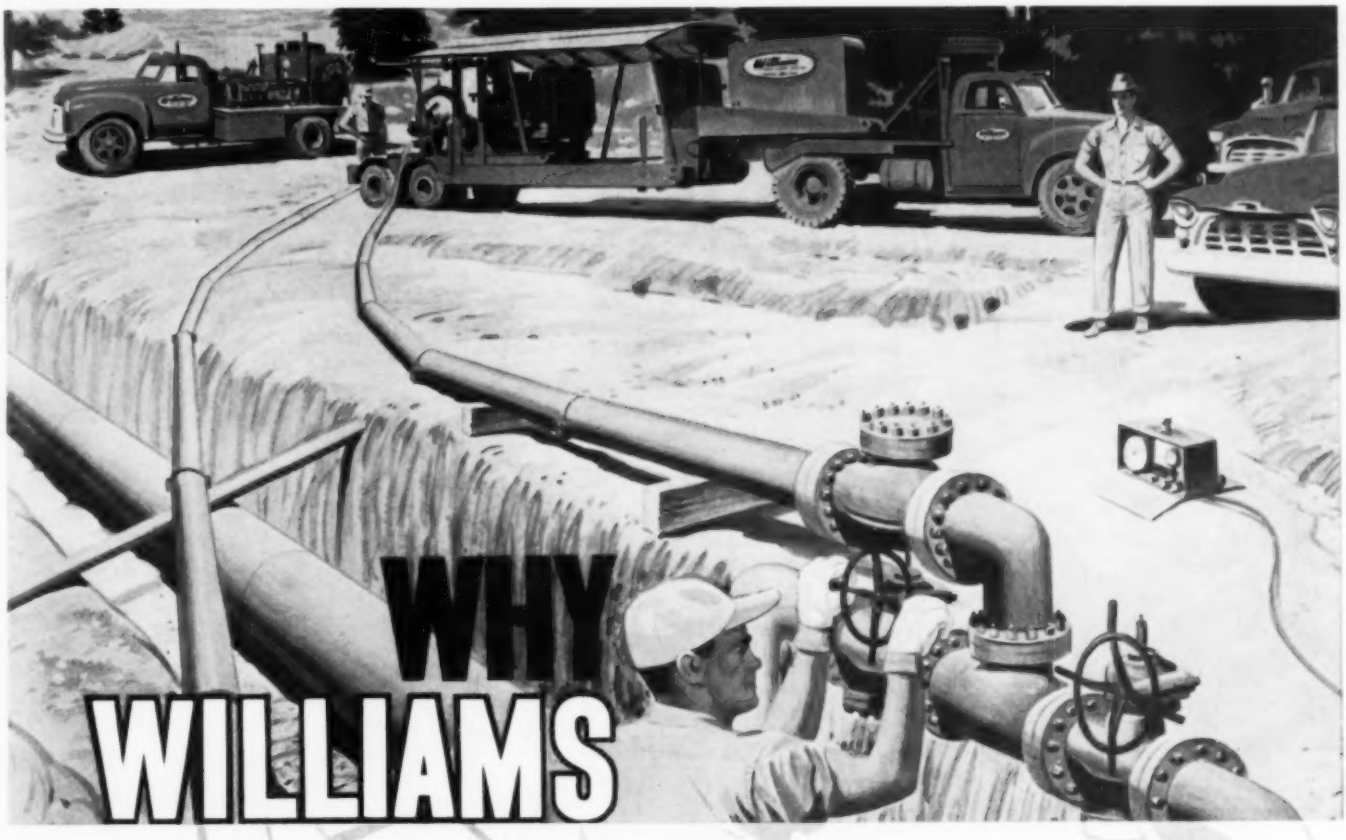

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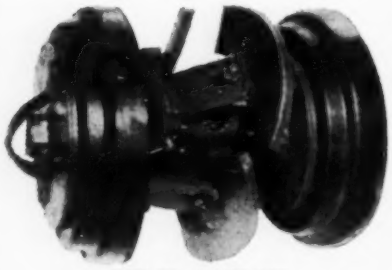
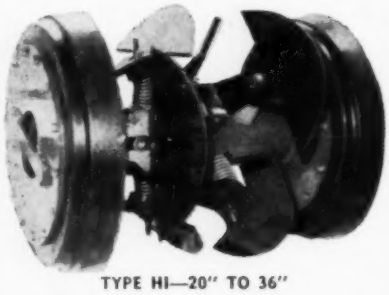


TYPE HI—6" TO 18"



TYPE HI—20" TO 36"

TYPE HI—6" to 36"

The latest development in pipe cleaning tools.

CONSTRUCTION

These springs extend through the center of the unit to blades on the opposite side of the unit which gives it a maximum of flexibility. The heavy springs on this unit help to keep it centered in the pipe supporting its own weight which will give far greater cup life.

DESIGN

This unit is ideal for first run on new construction, or for extremely corroded pipelines.

PIPELINE CLEANERS CO.

FORT MADISON, IOWA
PHONE DRake 2-2051

PROPOSED CONSTRUCTION

continued

Ohio Fuel Gas Co., 59 miles, gas, 4-24-inch main lines, in Belmont, Carroll, Cuyahoga, Fairfield, Logan, Lorain, Marion, Muskingum, Stark and Wayne counties, Ohio, $5.1 million, planned.

Pacific Gas & Electric Co., San Francisco, 296 miles, 36-inch, gas, from Malin, Ore., to Antioch, Calif., southern section of line from Canada to California, $82 million, contract let to **H. C. Price Company.**

Pacific Gas Transmission Co., San Francisco, 614 miles, 36-inch, Kingsgate, B.C. to Malin, Ore., northern section of Canada to California line, $133 million contracts let to **H. C. Price Co., Western Pipe Line, Inc.,** and **J. P. Neill and Co.**

Panhandle Eastern Pipe Line Co., Kansas City, 305 miles, 30-inch, 40 miles, 26-inch, gas, loops, and 43,000 hp, and gathering facilities, $60 million, before FPC.

200 miles, 22-24-inch, gas, lateral, from Elk City, Okla., to Haven, Kan., before FPC.

Peoples Gas Light & Coke, Chicago, 29 miles, 36-inch, gas between North Shore and Calumet stations, planned.

Peoples Gulf Coast Pipeline Company, Chicago, 27 miles, gas and turbocharger additions to 71 compressor engines, befor FPC.

Rio Gas Gathering Co., San Antonio, 97 miles, 3 to 8-inch, gas gathering, South Texas, to supply gas to El Paso Natural Gas Company, planned.

Southern California and Southern Counties Gas Cos., Los Angeles, 93 miles, 34-inch, California-Nevada border to Newberry, Calif., approved.

St. Lawrence Gas Company, Inc., Ogdensburg, N. Y., 75 miles, gas, main, United States-Canadian border to Ogdensburg, N. Y., $3.4 million, FPC examiner approval.

Tennessee Gas Pipeline Co., Houston 191 miles, 30 and 36-inch loops, in Ohio, Pennsylvania and New York, 72 miles of gathering lines and 43,600 hp in five stations, $46 million before FPC.

158 miles, 36-inch, gas, loops in Mississippi and Louisiana, FPC authorization.

21 miles, 16-inch, 2 miles, 12-inch, gas, Louisiana coast, Vermilion blocks 46 and 64, $3 million, before FPC.

Texas Eastern Transmission Corp., Shreveport, La.

66 miles, 30-inch, gas, loops, between Vidor, Texas and Lambertville, N. J., and 33,710 hp in four existing stations, $17.5 million, before FPC.

Extension of products line from Lebanon, Ohio, to Elmira, N.Y., considered.

350 miles, 24-inch, coal slurry, West Virginia to New York, considered.

Transcontinental Gas Pipe Line Corporation, Houston.

211 miles, 36-inch, and 69 miles, 30-inch, loops and additional 32,040 hp,

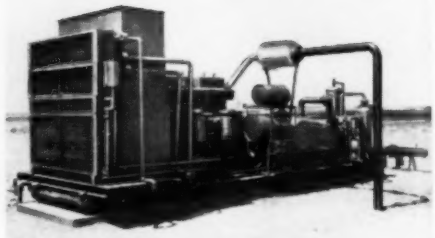
Continued on Page 78

WAUKESHA

for reliable and profitable

COMPRESSOR POWER

Waukesha 1197 cu. in. engine driving packaged gas booster unit—Oklahoma



Waukesha 3520 cu. in. engine on heavy duty compressor application—Texas

All the proven features that insure long engine life and the ability to withstand overloads, and that result in low maintenance costs and economical operation, are built into these Waukesha engines . . . from precision-counterbalanced rugged crankshafts; pistons, rings, and rod and pin assemblies in matched sets, to built-in automatically lubricated governors and big capacity cooling and oiling systems. The line is complete; you can get exactly the right power for your needs. You can't buy better engines for continuous heavy duty compressor operation.

SEE OUR CATALOG IN PIPE LINE CATALOG

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- *Can be used for remote measurement—over limitless distances*
- *Exceptionally fast speed of response*

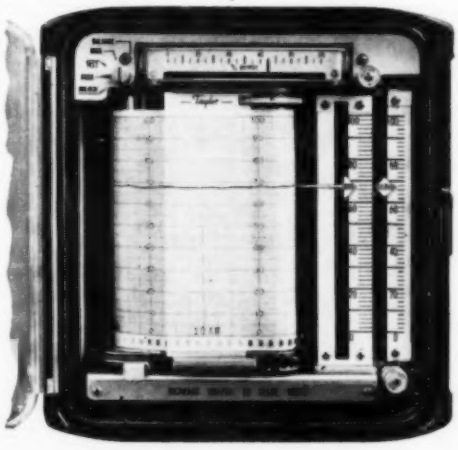
without sacrificing *Dependability* and *Quality*. Here's why:

No. 700R Electronic Controller

- Provides smoother transfer of suction discharge pressure and/or flow override control because there is no "reset wind-up".
- Much faster than any other electronic controller—flat out to 120,000 cpm.
- Rate action available down to 0.0016 mins.
- Gives smooth start-up on booster stations because diode limiter circuit eliminates reset wind-up.

No. 707T Electronic DP Transmitter (Left)

- Extremely reliable for unattended stations. Has no vacuum tubes, no transistors. Unaffected by vibration.
- Ideal for use where paraffin is present because nothing exposed to the process except end plates (steel or 316 stainless steel) and 316 stainless steel diaphragms.
- Can be used with reciprocating as well as centrifugal compressors because of internal silicone damping—continuously adjustable to damp out pulsations from 5 to 100 cpm.
- Cannot be damaged on remote station start-up because of full over-range protection to 1500 psi—either high or low sides.



No. 700J AC or DC Electronic Recorder (Left)

- Powerful servo motor provides accuracy of ½ of 1%, sensitivity to changes of 0.1% in input signal.
- Simplified tie-in of subsequent operations or auxiliary equipment permitted by operation of integral servo-operated alarms.
- Big 4" rectilinear chart gives 30 day record (1" per hour).
- Completely transistorized, unaffected by ±10% line voltage variation.

• • •

Call your Taylor Field Engineer, or write for appropriate bulletin.
Taylor Instrument Companies, Rochester, N.Y., or Toronto, Ont.

Taylor Instruments MEAN ACCURACY FIRST

SCAM®
DE-LINE
THE ENGINEER'S

ANNUNCIATOR
GREATEST FLEXIBILITY IN THE FIELD

AVAILABLE IN MANY SEQUENCES

BACKLIGHTED
OR
BULL'S-EYE

SIDE BY SIDE OR STACKED, DE-LINE modular design retains original custom appearance as system grows.

SAME PLUG-IN operates from normally open OR normally closed trouble contacts.

AUXILIARY CONTACTS N.O.-N.C. standard with most plug-ins.

SEQUENCE OPTION after installation by means of independent slide switch at each point.

DE-LINE plug-ins are self-policing. Systems are rugged and dependable.

THE SCAM INSTRUMENT CORP.

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Representatives In All Principal Cities
Complete Monitoring Systems for Industry

PROPOSED CONSTRUCTION

continued

in Texas, Louisiana, Mississippi, Alabama, Georgia and South Carolina, $52 million, FPC examiner approval.

13 miles, 24-inch and 18 miles, 20-inch loops, Louisiana, FPC authorization. 14 miles, 16-inch laterals, 1-mile, 12-inch lateral, Louisiana, $2.1 million, FPC authorization.

29 miles, 20-inch, gas, and 2,500 hp, in South Texas to take gas from South Texas Natural Gas Gathering Co., $2.4 million, FPC authorization.

Trans-Southern Pipeline Corp., Houston, 1,080 miles, 12-inch, LPG, from Mont Belvieu, Texas, to Danville, Va., and 215-mile spur line from Atlanta to Georgia-Florida border, $63 million, planned.

Transwestern Pipeline Co., Houston, 24 miles, 8-inch, 3,520 hp station and additional 1,000 hp, $2.5 million, temporary FPC authorization.

Trunkline Gas Company, Houston, 252 miles, 30-inch loops, and 140 miles, laterals, between Longville, La., and Tuscola, Ill., $45 million, before FPC.

Underground Storage & Exploration. Upper Darby, Penn., 394 miles, 12-inch LPG, from Moundsville, W. Va. to Newark, N. J., $9 million, approved.

95 miles, 6-8 inch, laterals to Mauch Chunk, Penn., and to Philadelphia, planned.

United Gas Pipe Line Co., Shreveport, La., 59 miles, 36-inch, gas, lateral between Bastian Bay field and Plaquemines Parish, La., before FPC.

Valley Gas Transmission, Inc., Houston. 55 miles, 3 to 8-inch, gas, gathering, in Hidalgo, Brooks, Starr and Jim Wells counties, Texas, $15 million, before FPC.

West Shore Pipe Line Co., 250 miles, 10-16-inch, products, East Chicago, Ind., to Green Bay, Wis., planned.

International

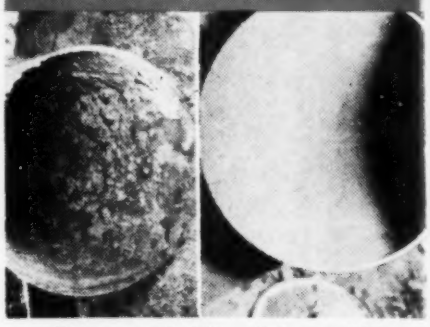
ACT Oils, Ltd., Montreal, 400 miles, crude, Dawson Creek, B. C., to Bella Coola, B. C., before B. C. government

Ajax Alberta Pipeline Ltd., 28 miles, 10-inch, gas, main, Morinville to Westlock, Alta., planned.

Alberta Gas Trunk Line Company, 386 miles, 26-36-inch, gas, main, Berland River area, Alberta, to Alberta-British Columbia border; and 235 miles, 8-18-inch, gas, gathering, Alberta, $100 million, contracts let to **Majestic Contractors, Ltd., Mannix Co., Ltd., Dutton-Williams Brothers, Ltd.,** and **Piggott Construction, Ltd.**

Alberta Natural Gas Company (Jointly owned by Westcoast Transmission Co. and Alberta & Southern Gas Co. Ltd.) 110 miles, 36-inch, gas, Alberta border to British Columbia-Idaho border, supply gas to Pacific Gas & Electric Co., contract let to **Price-Poole of Canada, Ltd.**

Continued on Page 82

Oakite ECP...


Clean bill of health for a choked-up mountain pipeline

This restoration job could have been a nightmare. Fourteen miles of twisting, turning pipeline in mountainous country . . . sections of pipe rising nearly 2000 feet in less than 9 miles . . . and inside those pipes, formidable deposits of sludge and scale.

Yet, an Oakite Engineered Cleaning Program restored this line to 92% efficiency . . . by making chemical analyses of the soil deposits . . . by pin-pointing the proper combination of detergent, tools and equipment.

What's an ECP? It's an Engineered Cleaning Program that takes into account *your* special requirements. The Oakite engineer lends his supervision and practical knowledge to the program.

Call your local Oakite man now. There's no obligation. Or write Oakite Products, Inc., 48 Rector Street, New York 6, N. Y.

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over 50 Est. 1909 SCIENCE years' leadership in industrial cleaning

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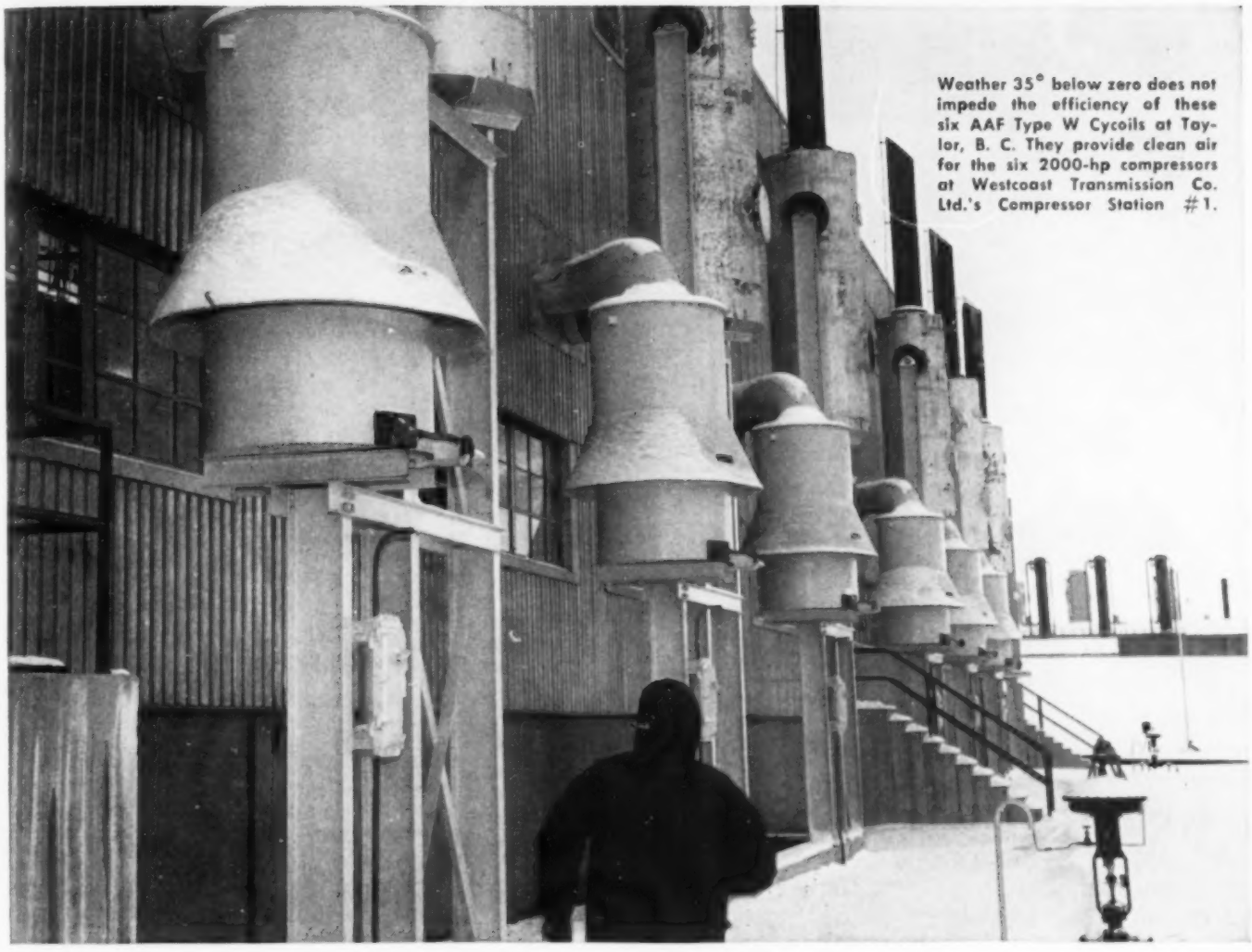

Weather 35° below zero does not impede the efficiency of these six AAF Type W Cycoils at Taylor, B. C. They provide clean air for the six 2000-hp compressors at Westcoast Transmission Co. Ltd.'s Compressor Station #1.

COLD ... but CLEAN ... CYCOIL air helps power Canada's Big Inch

Westcoast Transmission Co., Ltd.'s Compressor Station #1 – initiating station of Canada's new seven-station, 17-compressor, 52,500-hp Big Inch Line – is the northernmost complex of its kind in the western hemisphere. Here British Columbia "sour" gas is "sweetened", compressed, and started on its journey toward the U. S. border, more than 750 miles away.

Despite bitter cold, AAF Type W Cycoil oil-bath intake air filters efficiently and uninterruptedly provide clean air for the safe operation of six 2000-hp gas engines. The only concession to the cold – which sometimes reaches 50 below zero – is the use of Arctic-type oil!

Whether your operation is in the frozen north, a temperate region, or a hot and dusty desert . . . whether the application is pulsating action or smooth flow, packaged or stationary units, automatic station or not . . . AAF has filters *engineered* to match your requirements. For complete information, call your nearest AAF representative; or, write direct for Bulletin 130. Address: Mr. Robert Moore, American Air Filter Co., Inc., 450 Central Ave., Louisville, Kentucky.

AAF American Air Filter

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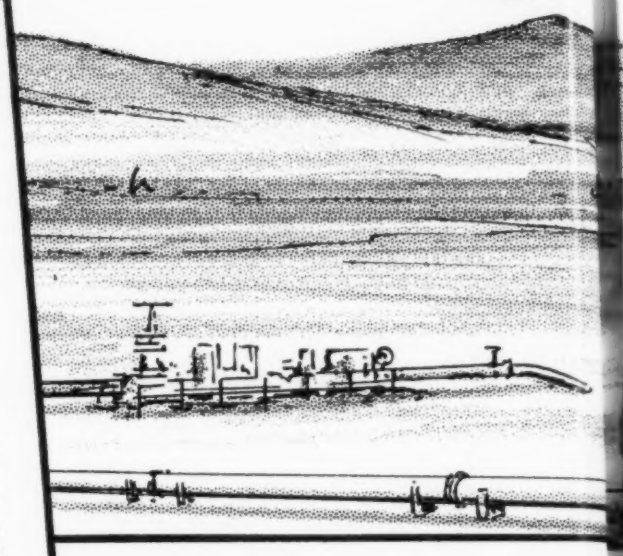
World's Largest LPG Pipeli



WILLIAMS BROTHERS COMPANY SPECIFY NEW BLOWOUT-PROOF GASKETS AS FLANGE SEAL FOR MID AMERICA'S 2,200 MILE PIPE LINE.

Engineers for Mid America Pipe Line Company, had to have a flange seal to meet some of the toughest specifications in pipe line construction. They wanted the best. They wanted a gasket with maximum effectiveness,(leakage rate equivalent to welding!) easy instaliation, long service life, and low maintenance cost.

After exhaustive tests and investigation they chose Gask-O-Seals. Said Williams Brothers engineers, "Primarily we had to have a seal that was blow-out proof. The controlled confinement principle used in Gask-O-Seals proved exactly what we wanted."

Several thousands of these amazing gaskets seal main line and subsidiary equipment on this 2,200 mile high pressure system — the longest and largest LPG line ever built. It runs from New Mexico and Texas, to Minnesota and Wisconsin. The line and its complexes will serve millions of customers providing low cost and better service with Propane, Butane and natural gasoline.

Re-Usable Gask-O-Seals Cut Maintenance Cost

When it's necessary to tear down a flange with a Gask-O-Seal in it the ease with which bolts are "broken" and nuts unscrewed is a revelation to men used to "cracking" flanges with ordinary gaskets. The reason is simple, you simply don't have to tighten bolts as tight with Gask-O-Seals . . . in fact, on construction sites for Mid-America's pipe line you never saw a "cheater!"

Even more amazing to pipe fitters is the fact that flange faces don't have to be cleaned and that the same gasket can actually be reinstalled!

The reduced maintenance cost mounts up to a really big saving when Gask-O-Seals are specified, whether in a pipe line, refinery, processing plant, or industrial plant.

WHY GASK-O-SEALS ARE SO EFFECTIVE--

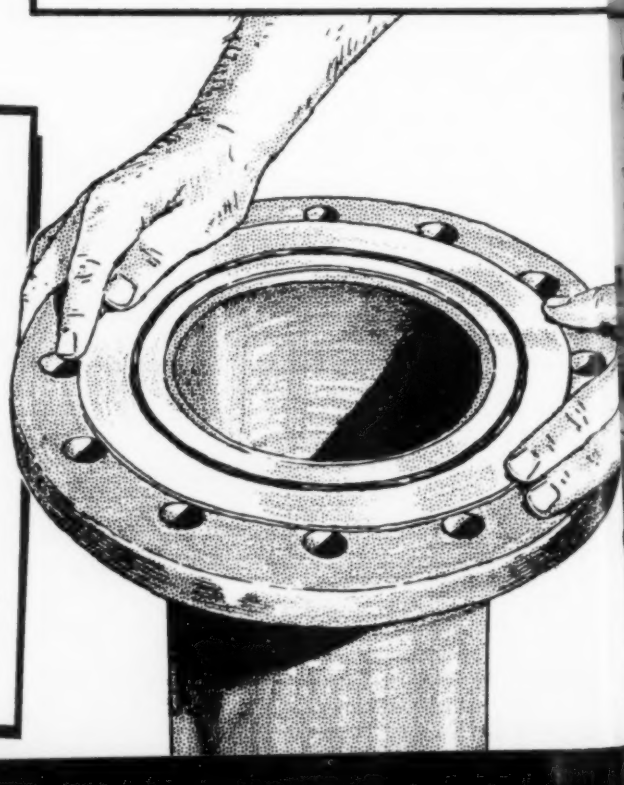
Gask-O-Seals are effective because of the sealing principle involved . . . controlled confinement. That means that the "rubber" mass to groove void is carefully controlled. The gland is totally confined with metal-to-metal contact of faying surfaces. The whole seal is designed and manufactured to carefully controlled tolerances. The Gask-O-Seal design allows very, very little area of attack on the seal itself by the materials being sealed.

Of course, there are many other features about the Gask-O-Seal that makes it unique as an effective, safe, sure seal. Some of them quite technical, others just common-sense reasons. The fact that they are used in so many vital apparatuses attests to their superior sealing effectiveness.

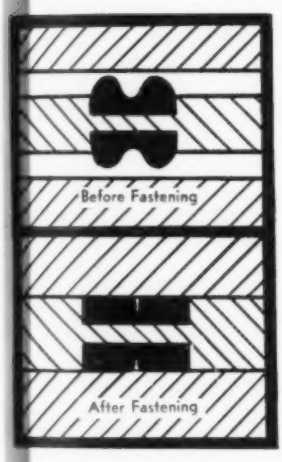
BUYERS FIND GASK-O-SEALS EASY TO ORDER—PRAISE DISTRIBUTION METHOD

Industrial buyers find that Gask-O-Seals are readily available and easy to order with a simplified "call out" system, tieing into standard ASA flange sizes and specifications.

In addition buyers preferring local sources usually find a Parker Seal Company stocking distributor close by. More and more distributors are requesting franchises as preference for Gask-O-Seals grows. "Many of these distributors are recommended to us by purchasing men as well as engineers," says Mr. T. J. McQuistion, Vice-president in charge of sales at Parker. "Such recommendations are very much appreciated. The company will gladly consider the request of any qualified distributor for a franchise on this new product line."



Line Uses Gask-O-Seals



Underwriter's Lab Tests Gask-O-Seals, Approve For Listing

LISTED UNDER REEXAMINATION SERVICE UL UNDERWRITERS' LABORATORIES, INC. OF

To be sure that customers could have confidence in the competitive safety of Gask-O-Seals, Parker Seal Company submitted all of standard ASA flange series seals to Underwriter's Laboratories for testing. They have approved all four of the series 6400, 6420, 6430, and 6440 for listing under their re-examination code, and granted permission to use their insignia for the services covered.

HOW TO SAVE *19 MINUTES* EVERY TIME YOU "BREAK" A FLANGE!

A testing foreman on Mid-America's pipe line saw Williams Brothers men installing Gask-O-Seals in flanges at the Conway, Kansas, Terminal. He turned to the Parker Seal Co. representative standing nearby and said:

"Man, go see my boss about those gaskets. I'm saving hours and plenty of money with them. We can just put 'em in for a test, break up and move, and *re-use the same gasket, over and over again!*"

A maintenance foreman said Gask-O-Seals may save them "2 days time of two 4 man crews-with trucks, wrenches and other equipment."

A survey shows it takes an average of 36 minutes to remove and install an ordinary gasket after several months use. With Gask-O-Seal it takes only 17 minutes! Here's how it breaks down:

3 minutes saved in "breaking" nuts, 3 minutes saved in parting flanges to necessary working space, 13 minutes in not having to clean and scrape flange faces — and you can install the same Gask-O-Seals you take out!

A worthwhile saving?

OVER 1,000,000 GASK-O-SEALS USED UNDER THE VERY TOUGHEST CONDITIONS BY AIRCRAFT AND MISSILES.

The sealing effectiveness and high safety factor of Gask-O-Seals were first recognized by the aircraft and missile makers to whom, safety, and genuine effectiveness of a seal is paramount.

Hundreds of tests have been run on Gask-O-Seals under some of the most rugged functional and environmental specifications a seal can undergo.

Today, Gask-O-Seals—much the same as the ones used on Mid America's new pipe line—are in use on practically every military and commercial aircraft. A Gask-O-Seal, for instance, seals the escape hatch and other openings of the Mercury capsule on the "man-in-space" project.

Parker SEAL COMPANY

Culver City, California and Cleveland, Ohio

A DIVISION OF PARKER-HANNIFIN CORPORATION

PROPOSED CONSTRUCTION

continued

Assistencia de Oleodutos du Petrobras, Rio de Janeiro, 280 miles, 12-inch, crude, Rio de Janeiro to Belo Horizonte, Brazil, planned.

Abu Dhabi Marine Areas Ltd., (British Petroleum Co. and Compagnie Francaise Des Petroles) 20 miles, 18-inch, crude, from Umm Shaif offshore oilfield to Das Island, Persian Gulf, planned.

Barnabos Group (Italian Interests), crude line from Venice, Italy, to Insbruck, Austria, with extension to Munich, Germany, planned.

Bituminous Oil Pipeline Co., Calgary, 250 miles, crude, from Athabasca tar sand plant in northeastern Alberta to Edmonton, approved.

British American Oil Co., Ltd., Toronto, 125 miles, gas, Pincher Creek fields to Calgary, Alta., before Alberta Public Utilities Board.

Burmah Oil Co., Ltd., 850 miles, crude, 20 inch, from Nahorkatiya to Calcutta, India. Contract let on 250 miles to Mannesmann-Saipem.

Cartier Gas Corp. (St. Maurice Gas, Inc., and Consumers Gas Co., Toronto), 170 miles, gas, Montreal to Quebec City, planned.

Consolidated Gathering Systems, Ltd., Calgary, 198 miles, crude, Sturgeon field to Edmonton, planned.

Creole Petroleum Co., 44 miles, 12-30-inch, gas, Bachaquero to Tia Juana, Venezuela, planned.

Foothills Pipe Lines Ltd., 1,300 miles, LPG, from Alberta-Saskatchewan border to Chicago, tie-in with Westalta Products Pipeline proposed system in Alberta, $100 million, before Alberta Board of Public Utilities Commissioners.

Gas Trunk Line of British Columbia, Vancouver, 250 miles, 30-inch, gas, main, Fort Nelson to Taylor, B. C., planned.

Gases Naturales de Colombia, S.A., 140-mile, 10-inch, gas, Cicuco field to Barranquilla, Colombia, planned.

Hughenden Pipeline, 125 miles, products, Dick Lake gasoline plant to Hughenden Region, Alta., planned.

Hydrocarbons Pipeline, Ltd., Winnipeg, Manitoba, 880 miles, 6-8 inch, products, from Edmonton to Winnipeg, $35 million, partial authorization.

Independent Pipe Line Co., 2,019 miles, 34-36-inch, crude, Edmonton to Montreal, 23,000 pump horsepower, $395 million, before Borden Commission.

Interprovincial Pipe Line Company, 350-mile extension from Toronto to Montreal, looping line from Edmonton to Toronto, crude, $240 million, considered.

Additional horsepower in four new stations and several existing stations, $9.3 million, planned.

Magna Pipeline Co., 25 miles, 4-inch, gas, Vancouver, B.C. to Vancouver Island, $14 million, approved by Public Utilities Commission.

Mid-Continent Pipe Lines, Ltd., 1500-mile, 30-inch crude, Edmonton to Chicago, planned.

Naphtha Israel Oil Co., 75 miles, 6-inch, gas, Rosh-Zohar field to Ashdod Yam on Mediterranean planned.

National Iranian Oil Co., 146 miles, 6 inch, crude, from Azna to Isfahan, Iran, $5 million, planned.

Northern Alberta Pipe Lines, Ltd., Edmonton, Alta., 110 miles, 10-inch, gas, main, Lac La Biche to Edmonton, $3 million, planned.

Northern Pipe Line Company, 153 miles, 16-inch, crude, from Regina, Saskatchewan, to Clearbrook, Minn., $10 million, planned.

Oasis Oil Co. of Libya, 100 miles, 30-inch, crude, Libyan production to Mediterranean, planned.

Peace River Oil Pipe Line Co., Ltd., 70-mile, crude, Swan Hills to Iosegun Junction, approved.

Pembina Pipe Line, Ltd., Edmonton, 1,200 miles, LPG, from Alberta gas fields to eastern Canada, planned.

Petroleos Mexicanos, 4, 6 and 8-inch, products, Mexico City-Puebla to Cuernavaca, planned.

Continued on Page 87

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There's no need to go-it-alone when your design problem deals with noise suppression. You can save time and money by putting a MAXIM engineer on your team.

He is a specialist in designing silencers to meet noise problems of all types of engines from giant diesels to "go-karts," as well as special purpose silencers for jet aircraft, atomic submarines, waste disposal plants, chemical plants and heat recovery applications.

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MODEL 60 INSULATOR

Mid-America Pipeline Company lines are insulated with the integrity of precision-designed, precision manufactured Maloney insulators. Injection-molded thermoplastic material. Standard sizes to 12 x 16 complete in two units. 14" line sizes and larger are in multiple units. All standard carrier/casing combinations are immediately available.

MOLDED CASING SEAL

Mid-America lines are utilizing this molded rubber casing end seal. Allows maximum lateral and longitudinal shifting of carrier. Minimum 3/16 inch thick in bellows, to 1/2 inch at shoulder. Thumbscrew locking, stainless steel banding furnished. Design eliminates additional rock shielding.

F. H. MALONEY COMPANY

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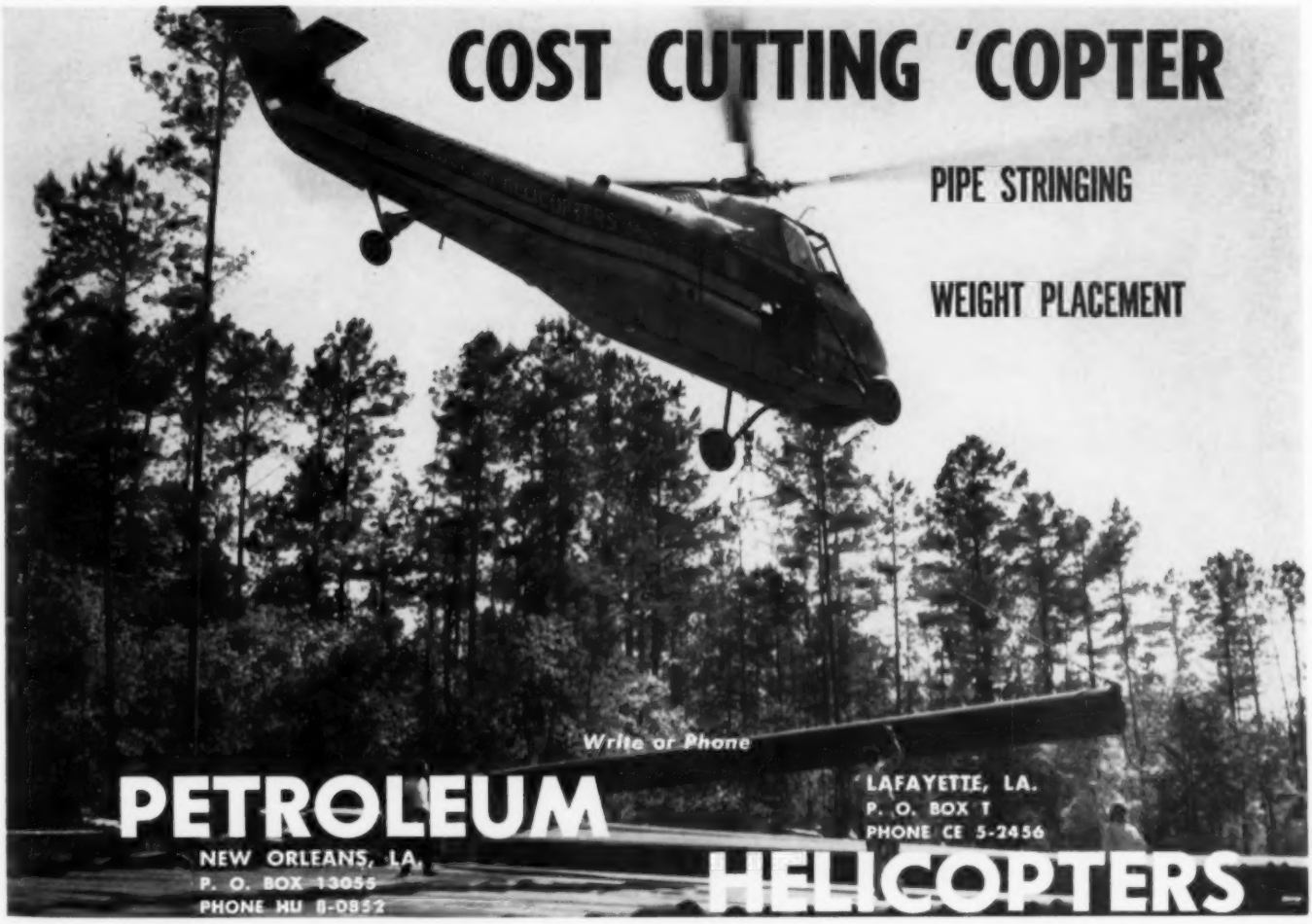


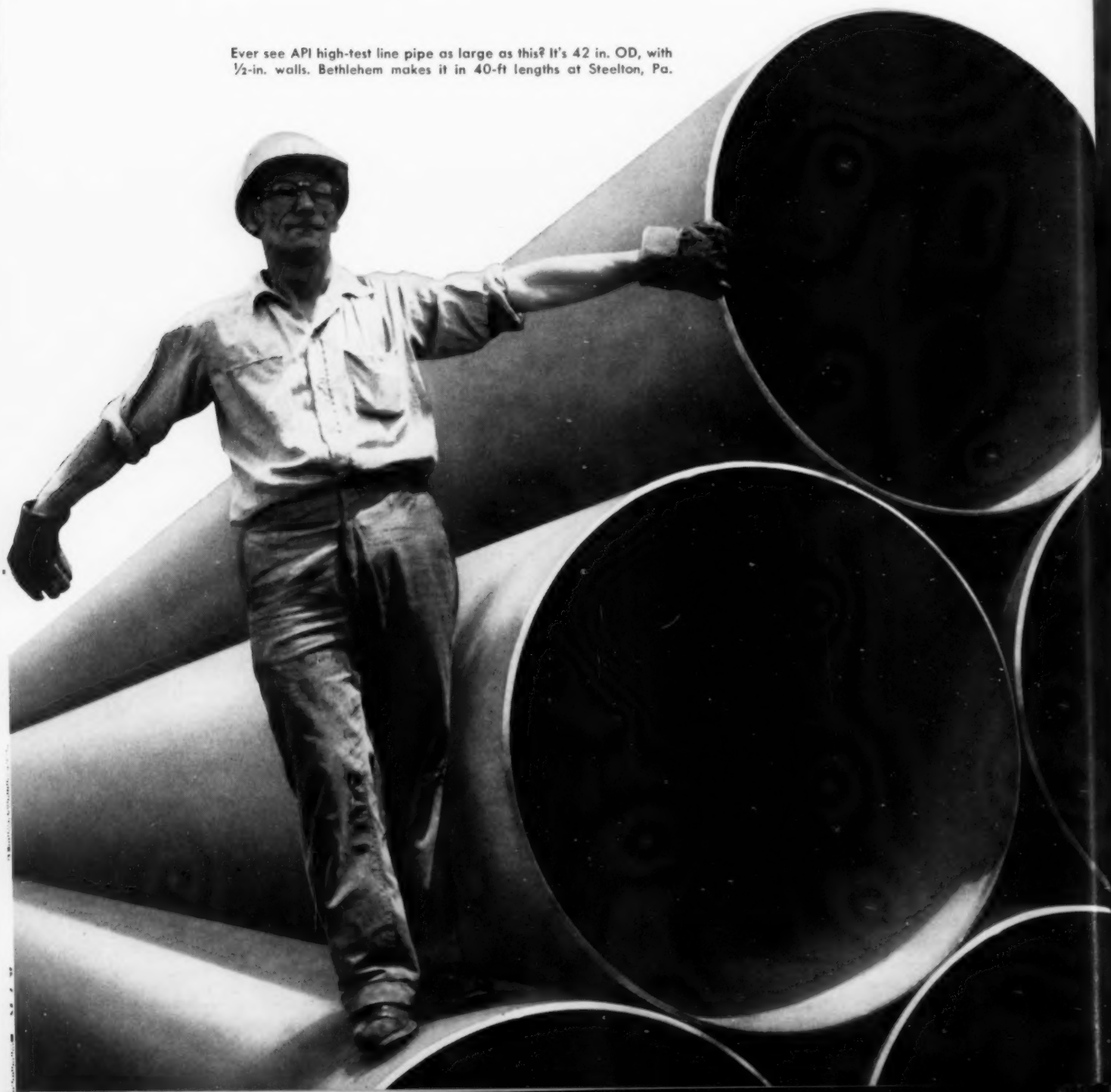
Need 42-in. Line Pipe?

Bethlehem makes it—electric fusion-weld line pipe from 18 through 42 in. OD, and with walls to $\frac{3}{4}$ in. in all diameters. Meets all applicable parts of API 5LX specifications. It's made at Steelton, Pa., on a completely modernized mill with capacity of over 35,000 tons a month.

Included among our newly installed facilities are edge and end planers, a U-ing press, an 18,000-ton-capacity hydraulic O-ing press, and batteries of inside- and outside-seam welding machines. The pipe is expanded hydraulically and end-faced.

It's a smooth-flowing, highly automated operation. Production is fast—quality is tops. For more information, call or write the Bethlehem sales office nearest you.

Ever see API high-test line pipe as large as this? It's 42 in. OD, with ½-in. walls. Bethlehem makes it in 40-ft lengths at Steelton, Pa.



How about 62-ft lengths?

Extra-long cars were required to ship this large order of Bethlehem 8⅝ in. ERW line pipe from our Sparrows Point, Md., mill. Lengths reached to 62 ft—that's mighty long pipe!

Bethlehem makes it—electric resistance-weld line pipe from $5\frac{9}{16}$ to 16 in. OD in lengths to 62 ft. Our modern pipe mills at Sparrows Point, Md., are regularly turning out these longer lengths for installation all around the country. Pipeliners like 'em, since they mean fewer welds in the field.

Bethlehem line pipe speeds up line construction in other ways, too. It's good, sound pipe, tested and re-tested at the mill to make sure it will test out OK in the line. Every length is straight as a stretched string, round in the body, and square and accurately beveled on the ends. It's pipe that will line up fast and take a good weld every time.

When you need l-o-n-g lengths of top-quality line pipe, call on Bethlehem. We have a sales office near you.

Steel

for Strength
. . . Economy
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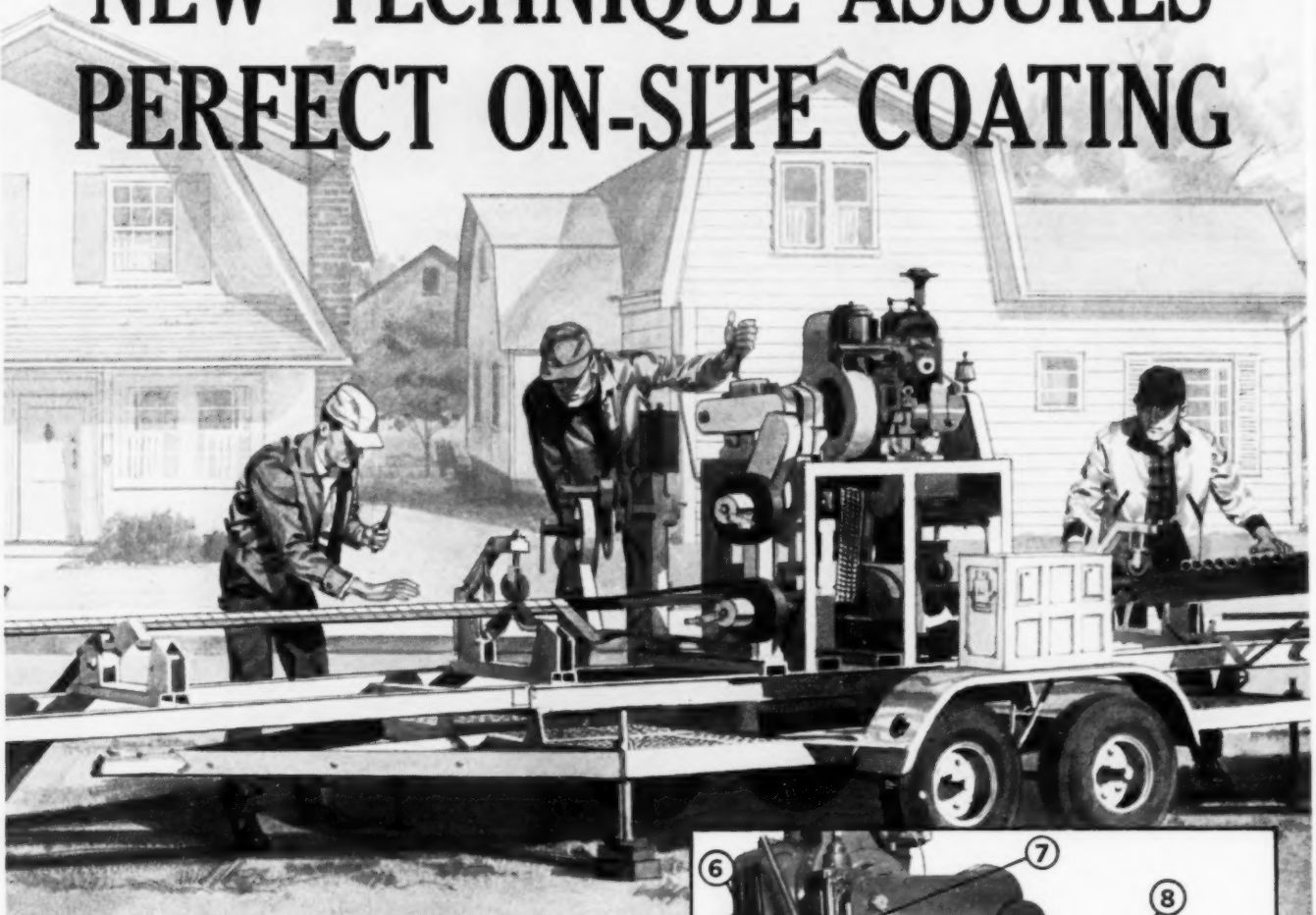
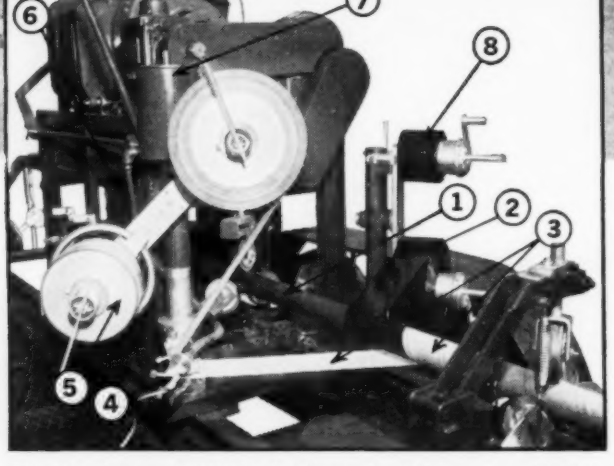
NEW TECHNIQUE ASSURES PERFECT ON-SITE COATING





Pipe (coming toward you) spins through machine . . . undergoes dynamic cleaning from twin-powered brush heads. Coating comes off brake-type tape drum. Outer wrapping runs through fast-gluing adhesive attachment.

1. Spinning pipe
2. Polyken tape coating
3. Outer wrap
4. Glue applicator
5. Stand-by outer wrap turret
6. Power brush heads
7. Glue tank
8. Stand-by tape turret

POLYKEN QUALITY PLUS UNIQUE APPLICATION METHOD MAKE TOP SITE-WRAP COMBINATION

Your protective coating results are only as good as the material you use and the way you put it on. And with Polyken tape . . . plus the special, new Polyken way of on-site application . . . you get a combination that really does a perfect job —*simply, speedily, economically.*

Simplicity? Right! The completely mobile machine sets up in an hour (knocks down in half that time), uses 6 men or less for continuous cleaning, coating, and wrapping. Speed? You can process up to 20,000 lineal feet a day, take 10-minute breaks to switch pipe sizes. Economy? Look at it this way: You get *quality* tape, properly applied by a high-speed *quality* process. The result can't help meaning more *dependable* coating for your dollar.

For the full story on both machine and tape, see your Polyken representative. It can mean maximum protection at minimum investment.

Polyken®

Experienced in modern PROTECTIVE COATINGS

THE KENDALL COMPANY
Polyken Sales Division

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Kansas City, Missouri
Industrial Coating's Engineering Co.

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Barnes & Delaney

Memphis, Tenn.
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Minneapolis, Minn.
Simcoe Equipment Co.

New Orleans, Louisiana
L. F. Gaubert & Co.

Philadelphia, Pa.
Harold N. Davis Co.

Plainfield, New Jersey
Stuart Steel Protection Corp.

San Francisco, Calif.
Incandescent Supply Co.

San Francisco, Calif.
Phillips & Edwards Electric Co.

Seattle, Washington
Farwest Corrosion Control Corp.

Seattle, Washington
Pacific Water Works Supply Co.

St. Louis, Missouri
Shutt Process Equipment Co.

Tulsa, Oklahoma
Midwestern Pipe Line Products Co.

Polyken

Experienced in modern PROTECTIVE COATINGS

PROPOSED CONSTRUCTION

continued

1,240 miles, 34-inch, gas, Reynosa to Mexicali, Mexico $160 million, negotiating with Tennessee Gas Pipeline Company for design and construction of the line.

8-inch, products, and 12-inch, gas Torreon to Chihuahua, to be built in 1960.

360 mile, 12-inch, products, Minatitlan to Puebla and Mexico City, construction to start in 1960.

Products, Guadalajara to Tepic, planned.

Products, Aguascalientes to Zacatecas, planned.

6-inch, products, Guaymas to Ciudad Obregon, considered.

8-inch products, Guaymas to Hermosillo, considered.

8-inch, gas, Tierra Blanca to Veracruz, to be built in 1960.

14-inch, gas, Mexico City to Salamanca, construction to start in 1960.

Gas, Ciudad Carmen to Ciudad Pemex.

8-inch, crude Comalcalco to Minatitlan, to be built in 1960.

Crude, Minatitlan to Salina Cruz, contingent on proposed refinery on Pacific Coast.

149 miles, 10-inch, products, Ciudad Pemex to Minatitlan, planned.

181 miles, 4-inch, products, Mexico City to Salamanca, planned.

Pipelines of Puerto Rico, Inc., 95 miles. 8-inch, products, Penuelas to San Juan, Puerto Rico, approved.

Provincial Pipe Lines, Ltd., 700 miles, 3-16-inch, hydrocarbon line gathering system in Alberta, $25 million, before Alberta Oil and Gas Conservation Board.

Quebec Gas Transmission Lines, Inc., Montreal, 300 miles, gas, main, Quebec to Montreal, planned.

Rangeland Pipe Line Company Limited, 111 miles, 8-inch, crude, southeastern Alberta to Calgary, $3 million, planned.

Saskatchewan Power Corp., 179 miles, 4-6-8-inch, gas, planned.

Societa Nazionale Metanodotti, 650 miles, 18-inch, crude, Genoa, to Milan-Cremona-Torino, Italy, and Aigle, Switzerland, with extensions to Karlsruhe and Munich, Germany, planned.

Societe d'Etude du Pipe Line Sud-European, Paris, 419 miles, 30-inch, crude. port of Lavera to Strasbourg, with lateral extending 40 miles to Karlsruhe. Germany, approved by French cabinet.

Soc. Siciliana Metanadotti, gas line from Hassi R'Mel field in Algeria through Tunisia, across Mediterranean to Sicily and into Italy, considered.

Standard-Vacuum Oil Company, 60 miles, 8-inch, gas, main, in South Sumatra, considered.

Ste. d-Etudes de Pipeline Intercontinetaux. Paris, 1,400 miles, 30-40-inch, gas, from Hassi R'Mel field in central Algeria across Mediterranean, through

Continued on Page 88

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PIPE JOINT CLAMP STOPS LEAKS
at joint where pipe is screwed into fitting

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PIPE JOINT CLAMP stops leaks at joints where pipe is screwed into fitting. Any temperature—any pressure up to 2,000 pounds. Saves the cost of tearing out and renewing leaky fittings. Prevents shutdowns. In stock at most oil supply stores.

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Spain, France and into West Germany, considered, Fish International Corporation making engineering and feasibility studies.

Sui Gas Transmission Co., Multan, Punjab, India, 145 miles, 8-inch, gas, from Sylhet to Dacca, East Pakistan, $9 million, considered.

130 miles, 16-inch, gas, main line, Multan to Lyallpur, planned.

Syrian Pipeline, Damascus, 500 miles, crude, from Karshuk field, Syria to Mediterranean, planned.

300 miles, products, from Homs to tank farms in Damascus, Aleppo and Latakia, planned.

Trans-Canada Pipe Lines Limited, Toronto.

268 miles, 34-inch, loops, and additional hp planned for 1961, $69 million.

122 miles, 34-inch, loops, hp additions, $46 million, planned for 1962.

Trans-Prairie Pipelines, Ltd., Edmonton, crude line, from Weyburn field to Regina-Moose Jaw areas, $5 million, considered.

Trans-Prairie Pipelines, Ltd., Edmonton, Alta., 159 miles, 4,6,8-inch, crude Milligan Creek-Boundary Lake are to Taylor Flats and Dawson Creek, contract let to **Banister Construction Co.**

Westalta Products Pipeline Ltd., 900 miles, LPG, from Northern Alberta to Saskatchewan border, to deliver hydrocarbons to Foothills Pipe Lines, $40 million, before Alberta Board of Public Utilities Commissioners.

Williams-McWilliams Industries, Inc., New York, 441 miles, 6-inch, crude, Villa Montes, Bolivia to Villa Hayes, Paraguay, considered.

Westcoast Transmission Company, 688 miles, 30-inch, gas, loops, Peace River area of British Columbia to United States border, planned.

Yacimientos, Petroliferos Fiscales Argentina, Buenos Aires, 1,000-mile, large diameter, gas, Comodoro Rivadavia to Buenos Aires, $300 million, considered.

Transco Lets Contract to Houston Contracting Company

Transcontinental Gas Pipe Line Corporation has awarded a contract to Houston Contracting Company for construction of about 45 miles of gas pipe line loops.

Houston will lay 15 miles of 30-inch in the vicinity of Kay, Texas, and about 15 miles of 30-inch near Dayton, Texas. Also, Houston will construct 8 miles near Kinder, La., and about 7 miles in the vicinity of Mauriceville, Texas.

Magnolia Pipe Line Lets Contract to Panama, Inc.

Magnolia Pipe Line Company has awarded a contract to Panama, Inc., to lay about 4 miles of 4 and 8-inch pipe line near Brookeland, Texas.

Trans-Prairie Pipelines Lets Contract on Crude Line

Trans-Prairie Pipelines, Ltd., has let contract to Banister Construction for 159 miles of crude line in British Columbia.

The line will consist of 53 miles of 4-inch, 30 miles of 6-inch and 75 miles of 8-inch extending from the Milligan Creek-Boundary Lake area to Taylor Flats and Dawson Creek. It will have a capacity of about 20,000 barrels per day and will be in operation in about one year.

Northern Natural Files For Expansion Project

Northern Natural Gas Company has filed with the FPC for permission to construct 62 miles of 16-inch pipe lines to provide sales of gas to Reserve Mining Company at Silver Bay, Minn.

Northern also would install 11 miles of 30-inch and install 5,400 hp in additional compressor capacity. This portion has already received conditional authorization. Total cost for the projects would be about $6 million.

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Service Pipe Line Co. Builds 22-Mile System

Service Pipe Line Company is building a 22-mile pipe line system to gather heavy Devonian crude oil from 31 leases in the Beaver Lodge Devonian pool at Williams County, N.D.

The project includes 11 miles of 6-inch gathering lines and 11 miles of 2-inch lateral lines to connect leases operated by Amerada Petroleum Corp. and Hunt Oil Co. Two 10,000-barrel tanks will be erected at Ramberg station, and 31 high-pressure field pumping units will be installed throughout the gathering systers.

Contractors are Oil Field Service Co., Inc., and Basin Pipeline Construction Co.

Mesa Pipe Line Co. Laying Gathering System

Mesa Pipe Line Company is installing a gas gathering system for gas liquids production from Azalea Strawn and Devonian fields in Midland County, Texas.

Mesa is constructing 55 miles of gathering lines and 7 miles of 4-inch main line from the station to Mobil Oil Company's terminal at Midland.

Natural Gas Pipeline Lets Construction Work

Natural Gas Pipeline Company of America has awarded contracts to Houston Contracting Company and M. L. Hulcher Co., Inc., for construction work.

Houston will lay 17 miles of 8-inch and 10 miles of 6-inch in Aransas and Refugio counties, Texas. Hulcher will construct two loop lateral lines to the town border stations for Princeton and Belvidere, Ill.

Seadrift Lets Contract On 56-Mile Product Line

Seadrift Pipe Line Company has awarded a contract to Sharman, Allen, Gay & Taylor, Inc., for construction of its dual 56-mile products line from Bay City to Seadrift, Texas.

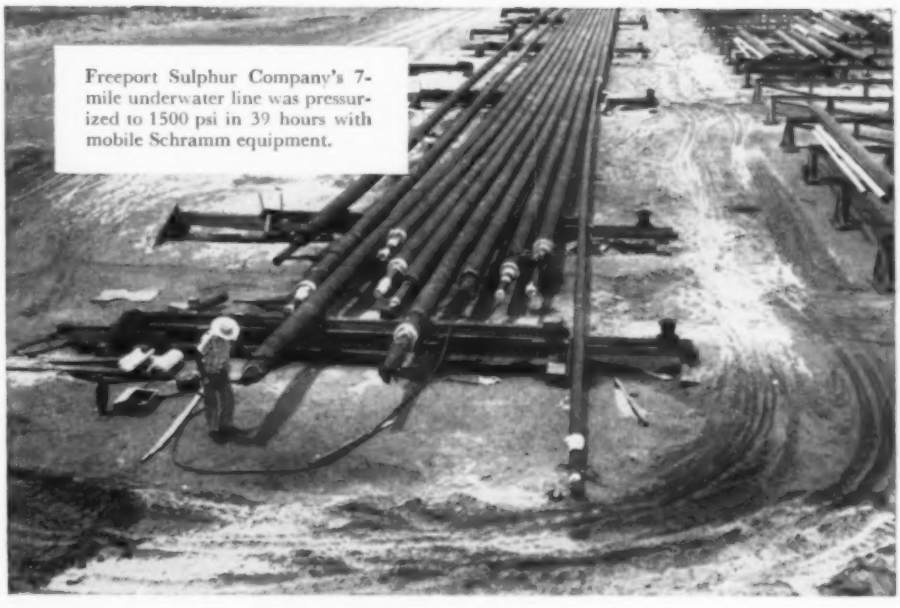
Louisiana Gas Producing Company Awards Contract

Ford, Bacon & Davis has been awarded a contract to construct 25 miles of 8-18-inch pipe line for Louisiana Gas Producing Company near Sterlington, La.

We've tested them high...

Overhead canal crossing for Eastern Shore Natural Gas Company was tested in 3 hours, 5 minutes under freezing conditions.

...and tested them deep



Freeport Sulphur Company's 7-mile underwater line was pressurized to 1500 psi in 39 hours with mobile Schramm equipment.

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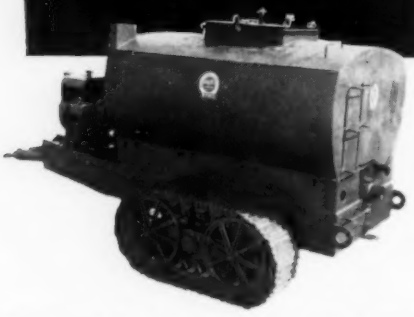

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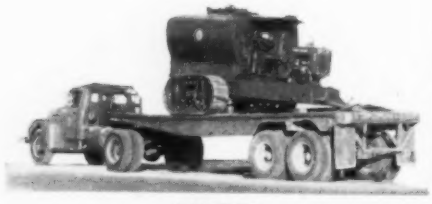

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Humble Agrees to Supply Gas for Mexican Line

Humble Oil and Refining Company has agreed to supply gas to the Southern California Edison Company from South Texas gas fields. The agreement covers a 20-year period and involves sale of about 1.8 trillion cubic feet of gas. Deliveries would rise to a maximum of approximately 265 MMcf of gas daily in the fifth year from a first-year rate of approximately 108 MMcf daily.

Signing of the gas supply agreement was the third step taken in the big project. Previously, Tennessee Gas Transmission Company and Petroleos Mexicanos signed an agreement for construction and operation of the 1,200-mile, 34-inch Mexican section of the system and for purchase of a portion of the gas from Pemex. Also, Tennessee and Edison signed an agreement providing for delivery of up to 455 MMcf of gas per day to Edison. (See PLI October, 1960, Page 60.)

Gas Trunk Line Completes 52 Miles of Gas System

Gas Trunk Line of British Columbia Ltd., has completed the first 52 miles of its pipe line system in northeastern British Columbia in a 30-day period. The line extends from the Buick Creek gas field north and west of Fort St. John to the Laprise Creek field.

Construction will begin on the Boundary Lake line, a 16-inch line which will join Taylor with the Boundary Lake field.

Engineering is under way on Gas Trunk Line's 250-mile, 30-inch main line from Chetwynd north to Fort Nelson.

Shamrock Laying 25-Mile Crude Pipe Line in Texas

Shamrock Oil and Gas Corp. let contract to H. A. McGinnis for 25-mile, 8-inch crude line from Clawson station in Hansford County and the Farnsworth area in Ochiltree County, Texas.

The line will replace a 6-inch line in existence.

Gas Service Company Buys Transmission Lines

Panhandle Eastern Pipe Line Company and Cities Service Gas Company sold 100 miles of gas lines to Gas Service Co. of Kansas City. Panhandle sold 819 miles and Cities Service sold 20 miles in the Kansas City area.

ON THE LINE

What's Ahead?

Speaking at the Southern Research Institute Conference on "Tomorrow's Transportation," Charles C. Whittelsey, president of Ford, Bacon and Davis, Inc., predicted great things to come for pipe lines.

Whittelsey commented that, "I could say that you could move anything you want through a pipe line," adding of course that the only things necessary are technical know-how and economic justification. Technical advances will come through practical experience and planned research.

Such things as orange juice, butter and parcel post probably could be piped. But the economic feasibility of these advanced lines depend on great markets. For a pipe line to operate with a profit, it cannot operate at only half capacity.

Whittelsey said that the same trend that prevailed in the past will develop the new type pipe lines. He pointed

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Partly compressed guide arms and knives are held tight but flexible against pipe walls by pressure of individual springs. Guide arms keep scraper in line, eliminating undue driver wear and prevents cocking. Flexibility permits Go-Devil to round bends.

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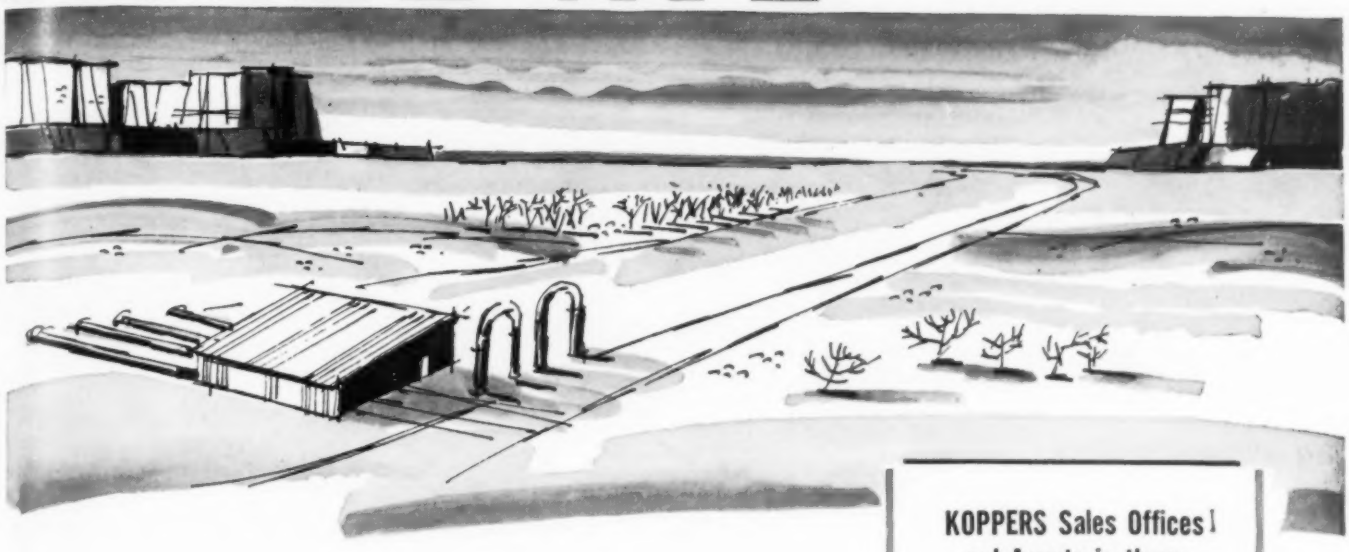

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out that the first crude lines served refineries and gas lines supplied industrial plants. "Future pipe lines will probably have the same pattern. Radical advances will involve sales to industries, not retail customers."

He also claimed that pipe lines will carry solids as well as fluids. "They will act as tremendous mixing vats, processing materials in transit. They will transport two, three or more materials at the same time."

Whittelsey declared "I think it is safe to say that we now possess the know-how to transport any inert solid material by pipe lines. Already we are doing it with coal, gilsonite, nickel-cooper concentrates, clay, phosphate matrix and even waste materials such as sludge and ashes. The question to be answered is, "Can you save money doing it? In more and more cases the answer is yes... a large and dependable market for these solids is all that stands in the way of widespread use of solids pipe lines."

Communications Discussion

The annual meeting of the American Petroleum Institute will be held at the Palmer House, Chicago, November 13-16. In a panel discussion November 14, E. H. Wilder of Sun Oil Company, will give his views on developments to be expected in the next 10 years in petroleum communications. Also on November 14, the Coordinating Committee of the Central Committee on Communications Facilities will meet to discuss matters of policy under the chairmanship of Wilder.

On November 15, the annual meeting of the Central Committee on Communications Facilities will begin and continue through November 16.

Quick on the Draw

Adam, Bill and Charlie were involved in a three-way pistol duel. According to the rules, they will draw lots to determine the order of shooting. The first has the right to shoot a single shot at either of his opponents. The second man, if he survives, has the right to shoot a single shot. Adam is a crack shot, Bill will hit a Bull's-eye two out of three times. Charlie is a bad marksman and is just as likely to miss his target as hit it. Who has the best chance for survival? (From the Rockwell Manufacturing Company October *Flow Line.)*

What's Happening among MEN in the INDUSTRY

Pipe Liners Visit Valve Plants

Thirty members of the School of Pipe Line Technology recently toured the Walworth LPV Division and Grove Valve and Regulator Company valve plants in St. Louis and in Longview, Texas. The school is sponsored by the API, Division of Transportation and University of Texas, Petroleum Extension Service and is conducted semi-annually at the Baytown Lee College. Seven company planes provided transportation for the three day trip and 10 company personnel accompanied the students. Among the members attending were 16 from foreign countries.

Walter L. Shannon

J. L. Irvin

In **Gulf Oil Corporation's** realignment of the domestic transportation system, **Walter L. Shannon** will be transferred to Houston as manager of domestic pipe lines under **J. L. Irvin**, president of **Gulf Refining Company.**

Irvin's responsibilities also will include management of the Domestic Traffic Department, engaged in arranging movement of oil by common carriers and of a fleet of inland barges as well.

Shannon worked in Gulf's Pipe Line Department at Houston for many years prior to becoming a vice president and manager of operations for Gulf Refining in 1957. In 1958 he became director of pipe line engineering for Gulf Oil at Pittsburgh. **William M. Johnson** has been transferred from Pittsburgh to Houston where he will be general traffic manager in Irvin's department. **Arthur Ernst,** manager of barge transportation in the consolidation of Gulf's transportation system at Houston, also has changed his headquarters from Pittsburgh to Houston. Irvin became president of Gulf Refining in 1957.

E. Clyde McGraw, president of **Transcontinental Gas Pipe Line Corporation,** will serve as president of Transco's newly formed subsidiary, **Trans-Southern Pipeline Corporation.**

Robert L. Topper will be executive vice president. Topper also is president of Trans-Jeff Chemical Corp. and executive assistant at Transco. **Don S. Willhelm** was named chief engineer for the new company, which was formed to build a $63-million LPG line from near Houston to Danville, Va.

Willhelm has been an engineer with Transco since 1950, and has been senior engineer in charge of special projects involving the operating departments for Transco.

Other officers include **John F. Burton,** vice president; **Wm. H. Davidson, Jr.,** vice president and general counsel; **James B. Henderson,** vice president; **Dan Williamson,** vice president, land; **A. E. Bryan,** treasurer, and **Tom H. Wheat,** secretary.

Northern Natural Gas Company and **Permian Basin Pipeline Company** plan to merge the companies. Northern presently owns 93.2 percent of Permian's common stock and 57.9 percent of the preferred stock.

Under the plan, common stockholders of Permian will receive a .75 share of Northern common stock for each share of Permian common. The 5.75 percent cumulative preferred stock of Northern will be issued in exchange for 5.75 percent cumulative preferred stock of Permian. Stockholders will vote on the plan at meetings November 30.

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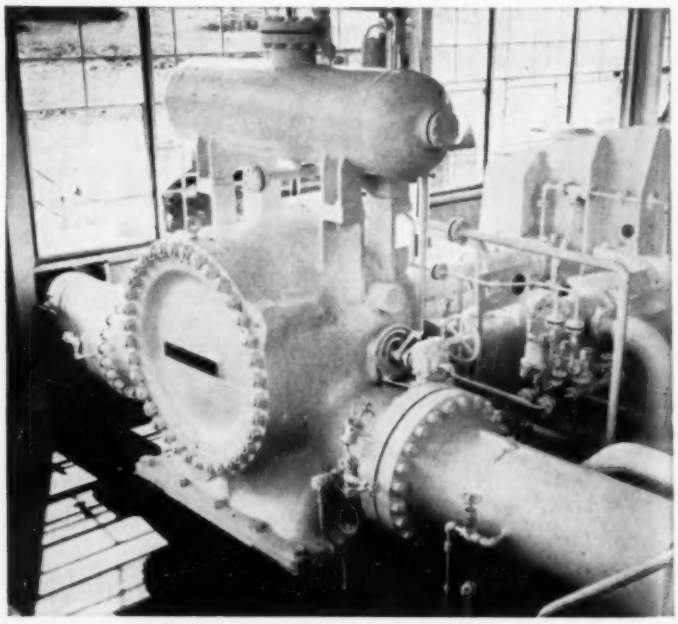
Produced by a special welding process developed by De Laval, this new welded wheel construction permits higher tip speeds and fewer stages for a given pressure ratio.

Write for more information on this new welded impeller or contact your local De Laval representative.



Rated at 20,000 horsepower, this compressor, on stream for a prominent pipeline company, is capable of developing a pressure ratio of 1.56 in a single impeller, pumping 800 MMSCFD at an inlet pressure of 652 psia and an outlet pressure of 1020 psia.

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W. E. Mueller, president of **Colorado Interstate Gas Company,** was elected president of the Independent Natural Gas Association of America. **W. M. Elmer,** president of **Texas Gas Transmission Corporation,** was named first vice president and **Orville S. Carpenter,** president of **Texas Eastern Transmission Corporation** was chosen second vice president. **Fred W. Peters,** vice president, secretary and treasurer of **Oklahoma Natural Gas Company,** was re-named treasurer of the association.

W. E. Mueller

Mueller joined Colorado Interstate as executive vice president in 1952, was named to the firm's board of directors in 1953, and was named president in 1954. He had been with the Tennessee Gas Transmission Company from 1943 to 1952. Elmer has been president of Texas Gas since 1947. He joined the company in 1948. Previously he was with the Memphis Natural Gas Company, predecessor of Texas Gas. Carpenter, who has been with Texas Eastern since its inception in 1947, became president of the company in 1956. He is also a director of the American Gas Association. Peters has served with Oklahoma Natural Gas Company since 1933. He was made vice president in 1950.

Natural Gas Pipeline Company of America announces several recent appointments. **M. L. DeCraene** has been named assistant general superintendent of pipe lines; **H. E. Boomer** becomes administrative assistant to the president; **T H. Beals** was named chief planning engineer, and **R. W. Lindgren** was appointed superintendent of development engineering.

DeCraene, superintendent of pipe line for NGPL since 1953, will assist **D. C. Palm,** general superintendent, in the newly created position. Boomer, superintendent of pipe lines for associate **Peoples Gulf Coast Natural Gas Pipeline Company** since 1958, succeeds Lindgren. Beals, who had been superintendent of development engineering since 1952, will be succeeded by Lindgren.

Texas Gas Transmission Corporation has appointed **Arthur H. Oesterheld** manager of systems and procedures. He will be responsible for analysis and evaluation of company wide systems and procedures, and the development of plans to achieve improvements and economies. Prior to his association with Texas Gas he was assistant comptroller for the New Haven Railroad.

Buckeye Pipe Line Company has announced a realignment of its operating divisions in Illinois, Indiana, Michigan and Ohio.

L. A. Miller, P. T. Dunkle and **E. R. Shearer** have been named superintendents of the newly established Lima, Cleveland and Toledo divisions, respectively. These divisions include both crude oil and products operations in their respective areas.

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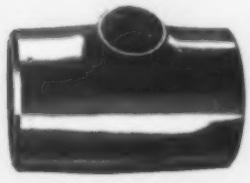

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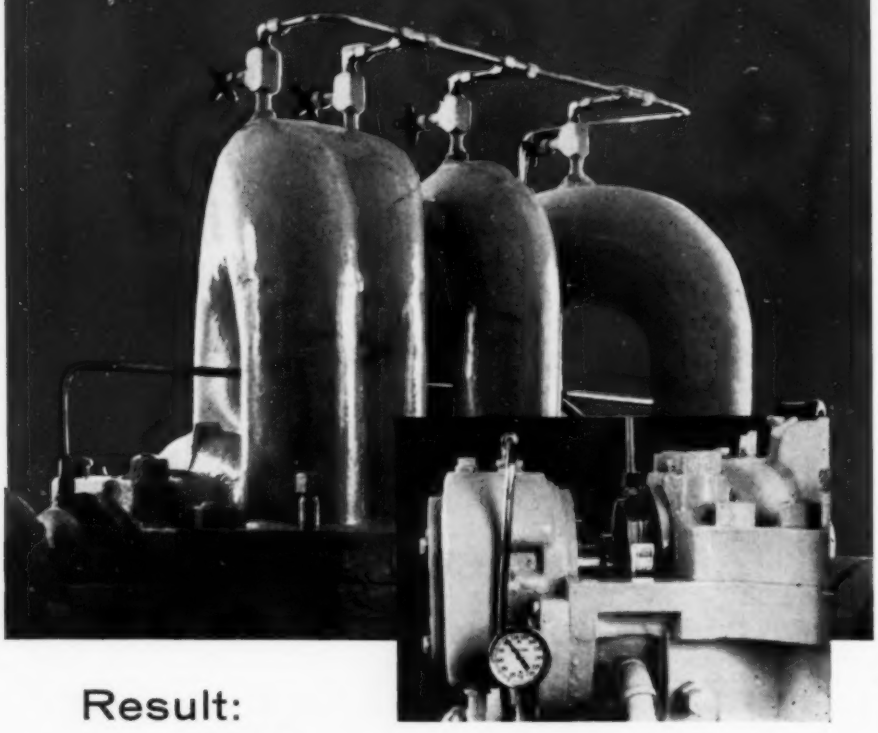
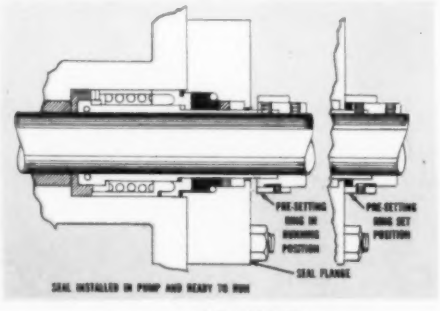


Result:
Up to 50% less maintenance

Since their first installation over four years ago, Atlantic Pipeline Company's Eastern Division has standardized on Borg-Warner Mechanical Seals on main line, booster and calibrating pumps. To date, experience with 26 pumps shows up to 50% less frequent maintenance; a marked decrease in product losses through leakage and evaporation; reduction of hazardous fumes; plus the economy of standard, interchangeable seals. Seals at Atlantic Pipeline's Product System operate under all conditions from inches of vacuum to 1300 psi, with *no pump down time due to seal failure!*

Here's how it works:

Complete Seal unit slips onto shaft —bolts to the stuffingbox. Pre-setting ring is then locked in running position to assure perfect spring tension.



*Pat. Pending

Borg-Warner Mechanical Seals

BW

DIVISION OF BORG-WARNER CORPORATION
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H. Nelson VerSoy

Vernon J. Jones

H. C. Price Coating Division announces three promotions. **H. Nelson VerSoy,** who has been Gulf Division manager, Harvey, La., for the past nine years, becomes general superintendent, Pipe Coating Division. He will be headquartered in Bartlesville, Okla.

Leo C. Carle, assistant Gulf Division manager for the past nine years, replaces VerSoy at Harvey. **Vernon J. Jones** has been promoted to the position of plant superintendent at Harvey.

Leo C. Carle

VerSoy joined the company in 1942, and served as welder, shop foreman and plant superintendent, prior to being named Gulf Division manager. Carle has been with Price since 1941, and was clerk-stenographer and office manager before his appointment as assistant to VerSoy. Jones joined Price in 1940, and worked as a laborer operator. For the past 17 years he has been foreman.

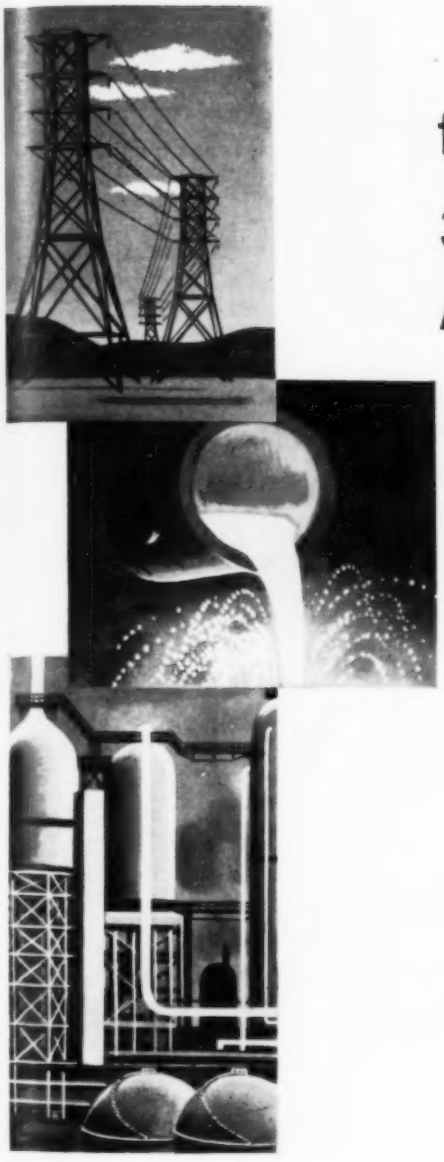
The American Society of Civil Engineers announces the election of nine new officers including president **Glenn W. Holcomb.** Holcomb, head of the Department of Civil Engineering at Oregon State College, becomes the ninety-second president of the 108-year-old society. Other officers elected include vice presidents for two-year terms and directors for three-year terms.

Donald H. Mattern, chief of Project Planning Branch for the Tennessee Valley Authority, was elected vice president for the ASCE Zone 11 which includes the southeastern section of the nation. **William J. Hedley,** chief engineer, Wabash Railroad, was named vice president for Zone 111, representing 19 states and some parts of Canada in the Central area. **Roger H. Gilman,** official of the Port of New York Authority; **Henry W. Buck,** in private engineering practice; **Earle T. Andrews,** vice president of the Pennsylvania Glass Sand Corporation; **John B. Scalzi,** United States Steel Corporation; **John D. Watson,** Watson Engineers, and **Harmer E. Davis,** University of California, have been named directors.

John Hawkinson, vice president and treasurer of Central Life Assurance Co. has been named to the board of directors of the **Mid-America Pipeline Company.**

He is a director of Central Life Assurance Company, Pioneer Finance Company, Home Federal Savings and Loan Association, Mill Owners Assurance Company and the Vernon Company. He also is a director of the Federation Chemical Company, and Douglas Oil Company.

RCA-110 Industrial Control Computer
RCA-130 Industrial Data Transmission Link
RCA-150 Industrial Data Analyzer and Recorder



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RCA-130 Industrial Data Transmission Link removes the limitation of distance in an automatic monitoring or control system. Provides reliable on-line, real-time, telemetering, alarming and remote control signal transmission of analog or digital information via wire or radio, one-way or two-way. 100% parity check of digital information. 100% continuity check of communications circuit. Frequency shift tone keying. Frequency multiplexing or time sharing of channel as desired. Remote reports may be self-initiating or centrally sequenced. Low power requirements. Application engineered from standardized modules to completely fulfill specific requirements at minimum expense. Operates with RCA-110, RCA-150, or custom display and supervisory operating console.

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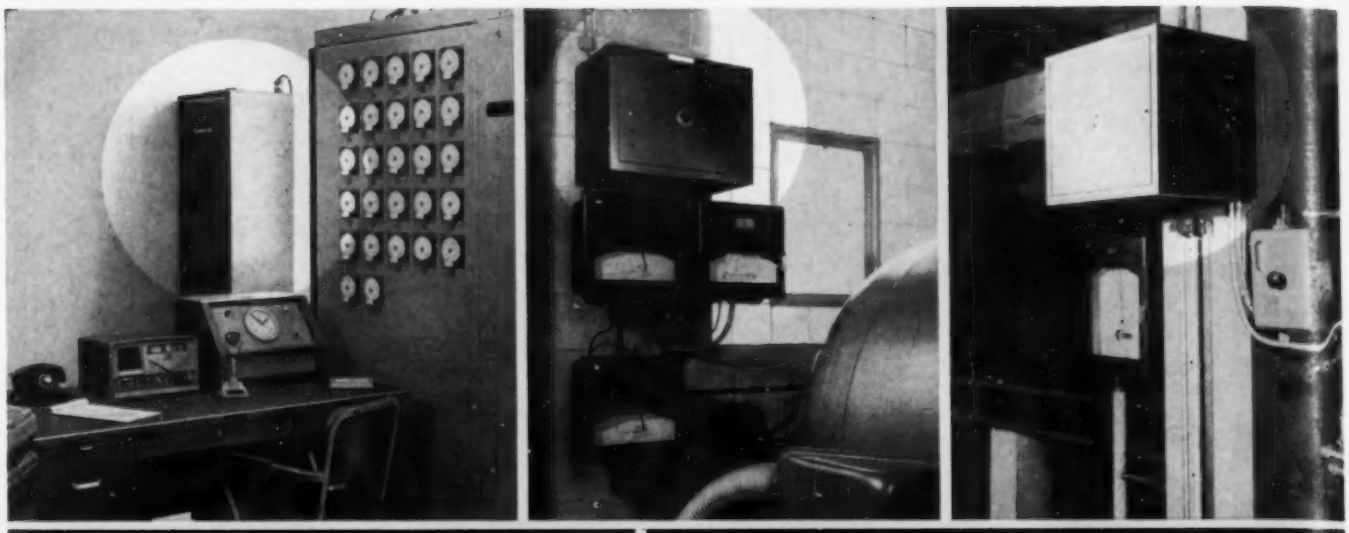

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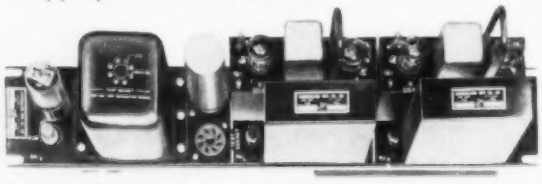
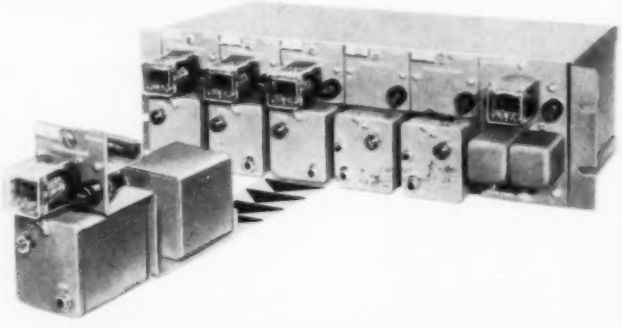
Hammarlund COC Tone Signalling provides Centralized Operations Control, transmitting all information from any point or points in a system to a central control station. Simultaneously, it provides the transmission of control for any function from the central station to the appropriate remote station.



STANDARD UNITS — Tone generators, transmitters, and receivers in complete modular design. Unique plug-in modules, plus built-in test sockets, and standardization of modules permits fast, easy field maintenance by non-technical personnel. Every standard Hammarlund Tone Unit is complete in itself with built-in power supply for complete flexibility or expansion of the system at any time.

COC Tone Signalling may be done over leased public telephone lines, private lines, or via radio links. It operates with all standard instrumentation and powered equipment such as motorized valves, pumps, starters, etc.



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Northern Natural Gas Company has formed a new company, **Northern Propane Company,** and appointed **P. A. Gass** as president of the subsidiary.

P. A. Gass

The new firm will develop retail propane markets in the Northern Plains area. Gass is also a senior vice president of the parent company, Northern Natural. Other officers of the new subsidiary, who are also officers of the parent firm, include **John Merriam,** chairman of the board, **H. H. Siert,** treasurer, and **B. H. Harper,** secretary. **R. K. Albon,** formerly vice president of marketing for the National Propane Company, has joined Northern Propane Gas Company as vice president.

Humble Pipe Line Company has reorganized its operating territories into three operational areas. The West Texas and North Texas Divisions were consolidated into the new West Texas Area, with headquarters in Midland. The Southern Division and East Texas Division were consolidated into the new East Texas Area, with headquarters in Houston. The Southwest Texas Division was renamed the South Texas Area, headquarters in Corpus Christi.

J. F. McCarthy is area manager in the West Texas Area. In the East Area, **P. H. Yolland** is area manager and **G. W. Oliver** is area manager in South Texas.

Service Pipe Line Company has named **Robert E. Boyle** assistant chief gager. He replaces **Bert M. Cromack** who retired in September after 39 years service with the company.

Boyle joined Standard Oil Co. (Indiana) in 1946. Six years later he was transferred to Service Pipe Line. After serving as an engineer he was placed on special assignment in the firm's Operating Department in April 1960.

Continental Pipe Line Company has announced the promotion of eight key men to new positions. **S. W. Ogan,** general superintendent of operations has been named manager of construction. **R. E. Lombard,** Oklahoma-Kansas-Illinois district superintendent, succeeds Ogan. **T. W. Sigler,** assistant superintendent of the Oklahoma-Kansas-Illinois district, becomes manager of new plans and projects. **W. E. Laughlin,** Louisiana district superintendent, was named to the newly created position of administrative coordinator. **W. F. Burke,** Rocky Mountain district superintendent, replaces Lombard.

W. P. Ilgen, Jr., assistant superintendent of **Yellowstone Pipe Line Company,** a Continental affiliate, was promoted to Louisiana District superintendent, succeeding Laughlin. **R. W. Lee,** temporary North Texas District superintendent, replaces Burke. **J. L. Walker,** assistant superintendent **Cherokee Pipe Line Company,** a Continental affiliate, succeeds Lee.

McClelland Engineers has opened its new Houston headquarters at 6100 Hillcroft Street. The new building has 6,000 square feet of floor space occupied by the company's offices, library, laboratory and shop.

Three transfers and promotions have been announced by **Panhandle Pipe Line Company. Richard L. Ryan,** former district superintendent at Maumee, was transferred to the same position at Glenarm. **Guy M. McElfresh** was promoted from assistant at Maumee to the district superintendent job there. **Carl L. Fennewald** was promoted from welder "A" at Zionsville to assistant at Maumee, replacing McElfresh.

Ryan replaces **S. R. Phillips,** who recently retired. Ryan had been superintendent since 1956. McElfresh had been assistant for three years. Fennewald had been at Zionsville for eight years.

Grove Lawrence has been elected president of the **Pacific Natural Gas Exploration Co.,** newly formed gas exploration and development subsidiary of **Pacific Lighting Corporation. Stuart T. Peeler** has been named vice president and secretary, and **Harry L. Bosshard** has been named treasurer and assistant secretary. Lawrence and Bosshard were elected directors along with Joseph D. Peeler.

Grove Lawrence

Bosshard previously was staff assistant in the Treasury and Tax Department of **Southern California Gas Co.** Stuart Peeler and Joseph Peeler are attorneys with the Los Angeles law firm of Musick, Peeler & Garrett. **Thomas A. Johnson, Jr.,** was named field manager for the new company. He had been gas reserves engineer with **Pacific Lighting Gas Supply Co.** Lawrence joined Southern California Gas Company in 1925 as an engineer. He was transferred to Pacific Lighting Gas Supply Co. in 1958 as a vice president and will continue to hold that position.

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, JULY 2, 1946 AND JUNE 11, 1960 (74 STAT. 208) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF PIPE LINE INDUSTRY, published monthly at 3301 Buffalo Drive, Houston, Texas, for October, 1960.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Wm. G. Dudley, 4742 Banning, Houston, Texas; Editor, Melvin A. Hadad, 806 N. Rice, Bellaire, Texas; Managing Editor, Wallace Fitzgerald, 5423 Lymbar, Houston, Texas; Business Manager, Robert M. de Sombre, 4410 Ingersoll, Houston, Texas.

2. The owner is: The Gulf Publishing Company, Houston, Texas; June Wooden Bliss, Houston, Texas; June Wooden Dudley Bliss—Trustee, Houston, Texas; Mrs. Grace C. Carter, Dallas, Texas; Margaret Dudley Cashman Trust, Houston, Texas; Drum & Company, c/o Trust Department, Houston, Texas; Fredrica Gross Dudley, Houston, Texas; P. Stinson Dudley, Abilene, Texas; Estate of Ray L. Dudley, Houston, Texas; William G. Dudley, Houston, Texas; William V. Gross Austin, Texas; Carolyn Dodson Keeble, Abilene, Texas; Anita S. Lane, Houston, Texas; Charles H. Lane (Deceased), Houston, Texas; James William Nelson, Baytown, Texas; Tom W. Nelson, Houston, Texas; Sallie Windham Ridley, Corpus Christi, Texas; Walter Gage Sterling, Trustee, Houston, Texas; O. R. Waller (Deceased), Chicago, Illinois.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: NONE.

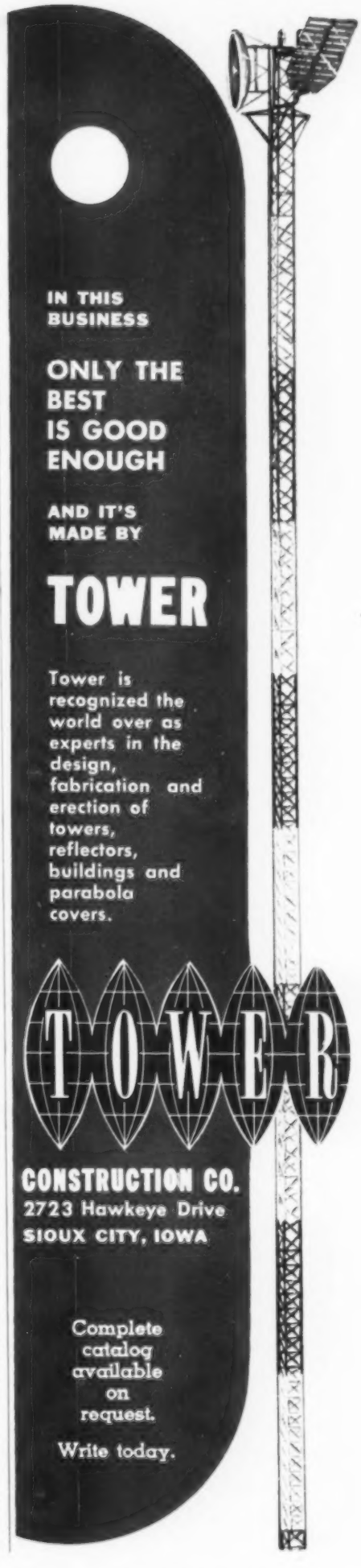
4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: 6,026.

R. M. de SOMBRE
Business Manager

Sworn to and subscribed before me this 28th day of September, 1960.

P. J. AUCOIN
(Seal) Notary Public in and for Harris County, Texas.
(My commission expires June 1, 1961)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WHO'S MEETING WHERE

November

NEGA Operating Division, Statler Hilton, Hartford, Conn., November 1.

NACE, annual Florida general conference, corrosion short course, Key Biscayne Hotel, Miami, Nov. 7-11.

AIEE, American Institute of Physics, sixth annual conference on Magnetism and Magnetic Materials, Hotel New Yorker, New York, November 14-17.

NACE, Canadian Region Eastern meeting, Sheraton Mount Royal Hotel, Montreal, Quebec, November 14-16.

API, annual meeting, Palmer House Conrad Hilton and Congress Hotels, Chicago, November 14-16

Natural Gas Pipeline Institute, court room, Court House, Liberal, Kan., November 15-16.

Institute of Radio Engineers, Mid America Electronics convention, Hotel Muehlebach, Kansas City, Mo., Nov. 15-16.

NGAA, Panhandle Plains Regional meeting, Herring Hotel, Amarillo, Texas, November 18.

ASME, winter annual meeting, Statler Hilton, New York, November 27, December 2.

January

Pipe Line Contractors Association, annual meeting, Fairmont and Mark Hopkins Hotels, San Francisco, January 15-18.

NGAA, Gulf Coast Regional meeting, Robert Driscoll Hotel, Corpus Christi, Texas, January 20.

February

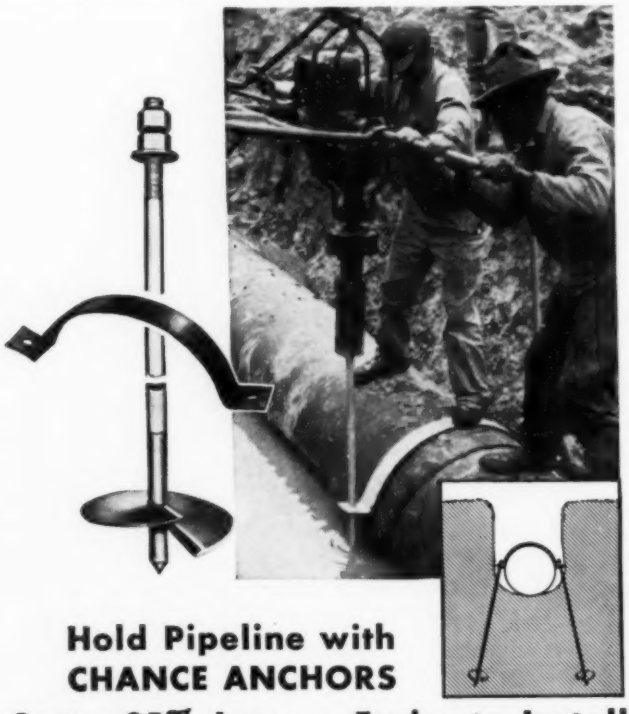
NGAA, South Louisiana Regional meeting, Lafayette Petroleum Club, Lafayette, La., February 24.

March

ASME, Gas Turbine Power Division, cosponsored by the Department of Defense, sixth annual conference and exhibit, Shoreham Hotel, Washington, D. C., March 5-9.

NACE, seventeenth annual conference, Hotel Statler, Buffalo, N. Y., March 13-17.

New England Gas Association, annual meeting, Hotel Statler, Boston, March 15-17.



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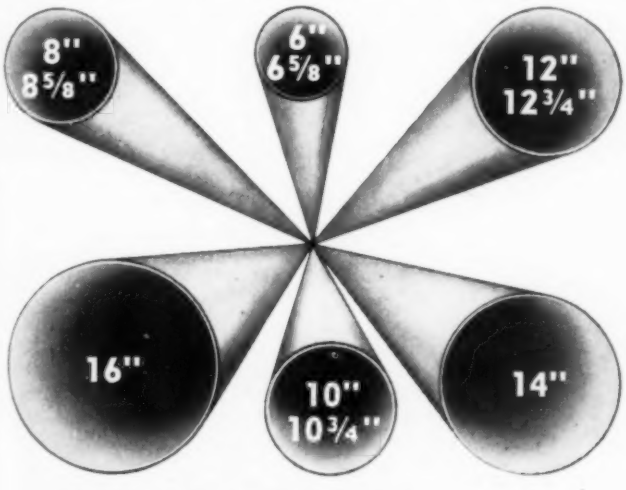

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NGAA, 40th Annual Convention, Baker Hotel, Dallas, March 15-17.

AGA General Management Section conference, Frances-Marion Hotel, Charleston, S.C., March 20-22.

American Society for Metals, 12th western metal congress and exposition, Pan American Auditorium, Los Angeles, March 20-24.

Mid-West Gas Association, annual meeting, Sheraton-Fontenelle Hotel, Omaha, Neb., March 27-29.

April

PIEA-PESA, annual meeting, Galveston, Texas, April 11-13.

Southern Gas Association, annual convention, New Orleans, April 24-26.

API, Division of Transportation, annual meeting, Chase Park Plaza Hotel, St. Louis, Mo., April 26-28.

NGAA, Oklahoma regional meeting, Lake Murray Lodge, Ardmore, Okla., April 28.

May

AGA, Transmission Section, annual meeting, Brown Palace, Denver, May 25-26.

NGAA, Permian Basin regional meeting, Lincoln Hotel, Odessa, Texas, May 19.

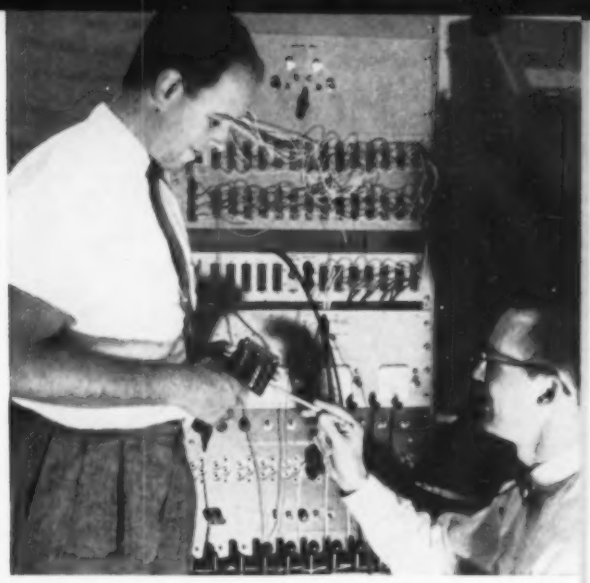
BOOKS

The Noise of Two-Spur-Gear Transmissions, M. W. Rosen, Naval Ordnance Test Station, U.S. Navy, July, 1959, 56 pages, $1.50.

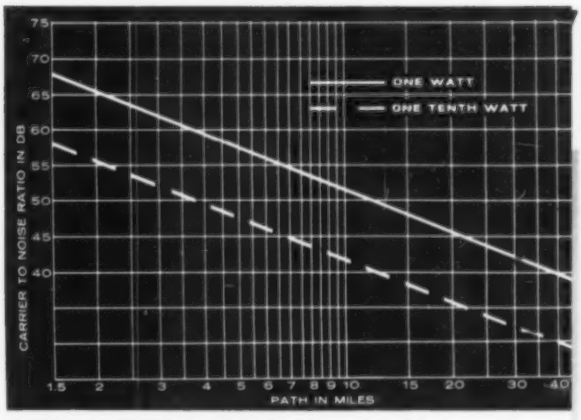
One of the Navy's biggest sound problems is the interference of gear transmission noise with sensitive acoustic equipment. Combating this problem, the Navy conducted tests of two spur-gear transmissions. As part of the research project a literature search was conducted to obtain information on the total acoustic energy generated with systematic changes in speed or power. Little data was found on sound measurements at extremely high gear speeds. The navy constructed an acoustic drive test device capable of operating at speeds up to 30,000 rpm. Because the noise of the test mechanism was negligible at high rpm, accurate measurement of the transmission noise level was possible.

Two spur-gear (straight-toothed) conventional planetary transmissions were tested at speeds up to 27,500 rpm, with as much as 70 hp. In developing the experiment, a rule of acoustic energy was evolved that the author feels may possibly be valid for all great trains. The rule is that the total acoustic energy radiated by the two spur gear transmissions tested is directly proportional to the power transmitted when the tooth velocity is held constant.

New MCR-1000 Microwave System.



Raytheon communications engineers work as a team with data processing specialists to insure optimum systems design.



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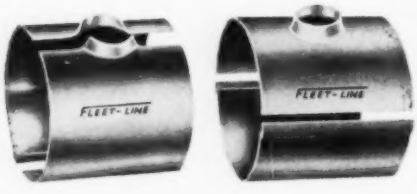

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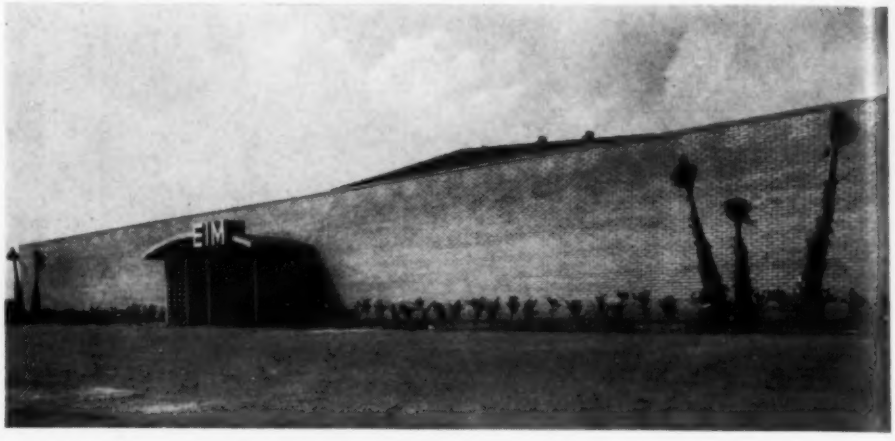
What's Happening among SERVICE and SUPPLY MEN



E-I-M Company Opens New Plant

The E-I-M Company has moved into its new plant on Pike Road at Missouri City, Texas. The new quarters will double manufacturing capacity of the company's automation equipment. Office space in which accounting, engineering and executive offices are located comprises 6,000 square feet.

W. F. Gulley

N. E. Davenport

Gulley Named Regional Manager Of Rockwell Manufacturing Company

William F. Gulley has been named assistant regional manager in the western region for Rockwell Manufacturing Company's Meter & Valve Division. He had been district manager at San Francisco for the Meter & Valve Division.

Nelson E. Davenport has been promoted to succeed Gulley at San Francisco. Gulley has been with the company since 1947 as sales engineer and became Seattle district manager in 1951. He was named to his recent post in 1955. His headquarters will remain in San Francisco. Davenport joined Rockwell as a sales engineer in 1950. He was named assistant product manager-gas products in 1955, export sales manager for meter and valve products in 1957, and most recently served as assistant to the vice president of petroleum and industrial sales.

Fry Sales Representative For Union Wire Rope Corp.

Union Wire Rope Corporation has appointed John M. Fry sales representative in Western Oklahoma and the Texas Panhandle sales. He will be headquartered in Oklahoma City.

He will have territory formerly handled by G. E. Giese, now branch manager in Oklahoma City.

Union Switch & Signal Names William Haley Southwest Manager

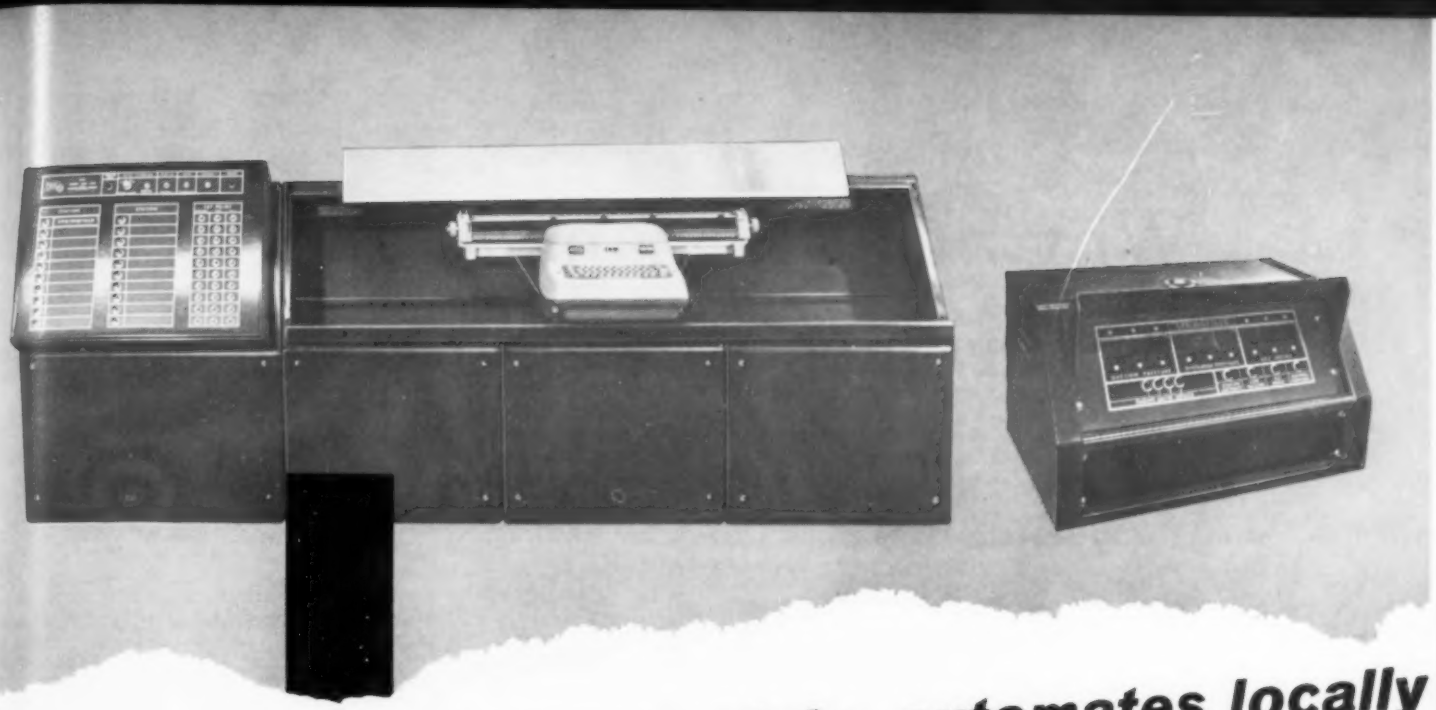
William F. Haley has been named manager of the newly established Southwest District office of Union Switch & Signal Division of Westinghouse Air Brake Company. Haley will headquarter in Houston and he will be assisted by William L. Hendricksen, sales engineer.

Haley joined the company in 1952 in the Simulator Engineering Department. In 1957, he was assigned to the Pipe Line Engineering Department. Here his duties involved application of systems control equipment to pipe line transportation industries.

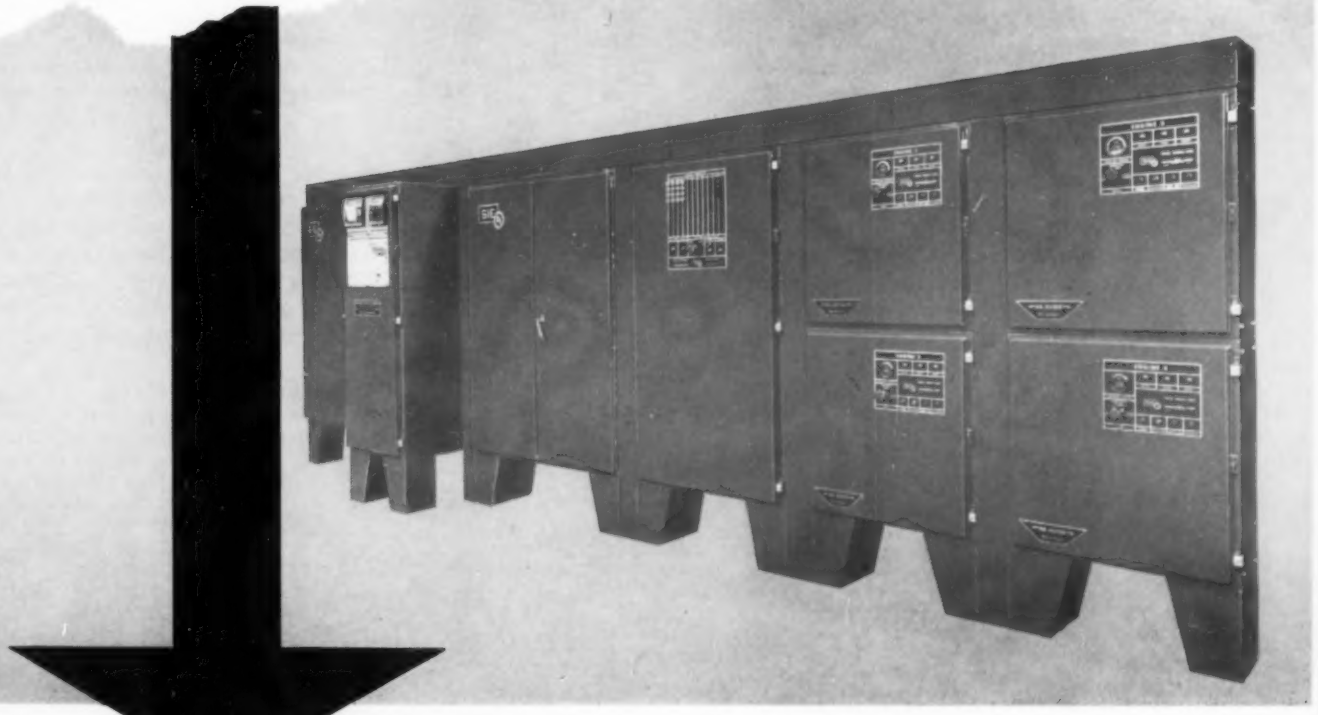
Branch Managers Appointed By E. H. Edwards Company

E. H. Edwards Company announces appointment of a division manager and two branch managers. Michael I. McCarthy has been named division manager, San Francisco, Fred M. Butler was made branch manager in Seattle and John W. Hockaday becomes Los Angeles branch manager.

McCarthy has been active in the heavy construction field in the west for more than 10 years. For the past year and a half he has served as Edwards sales representative in the Bay Area. Butler had been district manager in San Francisco since 1958. He has been with the company since 1937. Hockaday had been branch manager in Seattle for the past five years. He joined the company 12 years ago and for several years was manager of the Northwest territory.



why CIG supervises remotely, automates locally



Colorado Interstate Gas Company dispatchers transmit only desired discharge pressure settings; automation at each compressor station responds by maintaining the selected value for optimum system economy. ■ If communication links fail, local automation operates without interruption. Log-Alarm units insure station safety. Dispatchers are alerted only when trouble occurs. ■ Solid-state components assure maximum reliability. "Building-block" design allows SIE to fit your needs exactly. ■ Accelerate your operating cost reduction program by writing: **SOUTHWESTERN INDUSTRIAL ELECTRONICS**

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Division of Dresser Industries, Inc.

SIE

Why Solar designs industrial gas turbines to weigh between 1 and 1½ lb/hp

by Paul A. Pitt
Chief Engineer
Solar Aircraft Company

The weight of Solar gas turbines is the result of a design philosophy that is unique in the small gas turbine field.

Most gas turbine designs fall into one of two extreme categories. Aircraft-type engines, at one extreme, embody highly sophisticated techniques for extreme light weight in relation to horsepower, but have resulting short life. The opposite philosophy employs the ultra-massiveness of steam turbines to assure long life.

There are important disadvantages in both approaches when long life, reasonable cost, dependable operation, simple maintenance and easy transportation and installation are required. While aircraft-design engines (of ¼ to ½ hp/lb) can be modified and derated for longer service life, the resulting product is inherently delicate. This compromise inevitably results in short life.

Paul A. Pitt

On the other hand, massive design (of 10 lb/hp and up) leads to unnecessary structural bulk and introduces problems of thermal lag and distortion.

Since World War II, Solar has designed and built a variety of gas turbine units with characteristics that lead to both long life and low weight. The Saturn gas turbine engine, for example, is an 1100 hp unit intended specifically for industrial and military installations. It has a weight-to-power ratio of 1.1 to 1.4 lb/hp.

Although it is designed for long life, it utilizes only enough materials in its components to satisfy structural and thermal requirements. This approach resulted in a design that makes no compromises with durability and performance, yet meets the needs of industry for flexibility in a small package. It has an 1100 hp rating at a specific fuel consumption of 0.61 lb/hp-hr and a continuous rating of 1020 hp at 0.63 lb/hp-hr SFC.

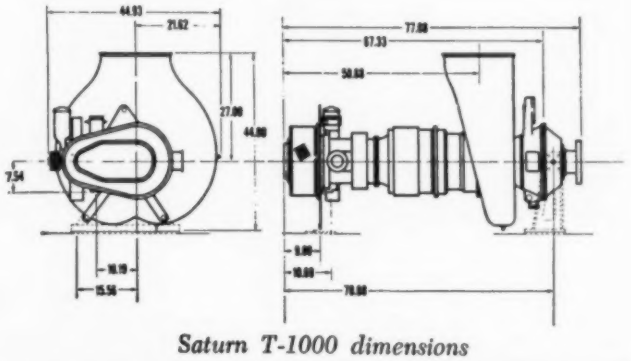
Meeting these objectives required an engine with a simple thermodynamic cycle and high efficiency components. An axial compressor was designed with an operating efficiency of 86%, and this was combined with a multi-stage, axial type turbine of advanced aerodynamic design. Over-all dimensions of the engine are shown in the figure below.

To fulfill workhorse service requirements, the engine was designed to operate at a conservative gas temperature of 1450 F continuous rating. The stress levels are also low, so that major rotating and stationary components will have more than 100,000 hours of life with long periods between overhaul. To keep costs down and assure dependability, the engine design is simple and straightforward.

In brief, the development program of the Saturn turbine adhered to three principles: Careful aerodynamic design for high performance; use of moderate temperatures and low stress levels for long life; and exhaustive component testing for ruggedness and reliability.

Presently scheduled field applications of the Saturn turbine include: Power source for 750 kw electric generator sets in process plants, portable field equipment, pipeline pumping, and gas compression in the petro-chemical industry. Other uses are as a power source for a 600 kw generator set in a commercial marine installation, propulsion units for marine and amphibious vehicles, and prime movers for off-highway vehicles.

Detailed data on Solar gas turbines and other turbomachinery is available. Write Dept. H-173, Solar Aircraft Company, San Diego 12, California.


Saturn T-1000 dimensions

SOLAR
AIRCRAFT COMPANY
A subsidiary of International Harvester Company

James O. Campbell

John W. Jennings

Clark Bros. Co. Announces Three District Appointments

Three district appointments have been announced by Clark Bros. Co. John W. Jennings has been promoted to sales representative—small engines for the Houston district. He had been application engineer in Houston. John L. Spencer, associate engineer with Clark since 1959, succeeds Jennings.

James O. Campbell, former application engineer, Olean, N. Y., Clark Turbo Marketing department, has been transferred to the Los Angeles district office as application engineer.

Peter C. Reilly Nominated As Honorary Association Member

Peter C. Reilly president of Republic Creosoting and Reilly Tar and Chemical Corporation, has been nominated for election as an honorary member of the Chemical Specialties Manufacturer's Association.

The nomination, approved by board of governors and based upon a resolution presented by the Policy Advisory Committee, is in recognition of Reilly's 10 years of service as treasure of the association. Membership will vote on the nomination at its meeting December 5.

Plicoflex, Inc., Appoints E. A. Roman Vice President

Edwin A. Roman has been appointed vice president of the Pipeline Products Division of Plicoflex, Inc.

Roman formerly was vice president and general manager of Plicoflex's major distribution organization and has been active in sales and service with the company for many years. He will be responsible for all phases of sales and technical service between the various distributors and the parent company.

W-K-M Division Enters Into Licensing Agreement

A licensing agreement for manufacturing and selling valves and fittings in Italy has been made by ACF Industries, Incorporated. The W-K-M division will provide design and technical and engineering assistance to Breda Fucine S.p.A. of Milan. The firm will make the W-K-M through-conduit gate valves.

Tex-Tube, Inc., Names Moore Project Engineer

Norton Moore has been named project engineer for Tex-Tube, Inc. He will supervise the introduction of new projects and services produced by Tex-Tube's research and development group. His first assignment will be supervising early field installations of the firm's new epoxy-joined line pipe.

He has been with Tex-Tube since 1955. He was made purchasing agent in 1957.

L. D. Moore Appointed By Allan Edwards, Inc.

Allan Edwards, Inc., announces the appointment of L. D. Moore as general office manager. Formerly, Moore was in outside manufacturing division of Douglas Aircraft Co. for five years, in the Sales Department of General Mills four years and operated his own business seven years.

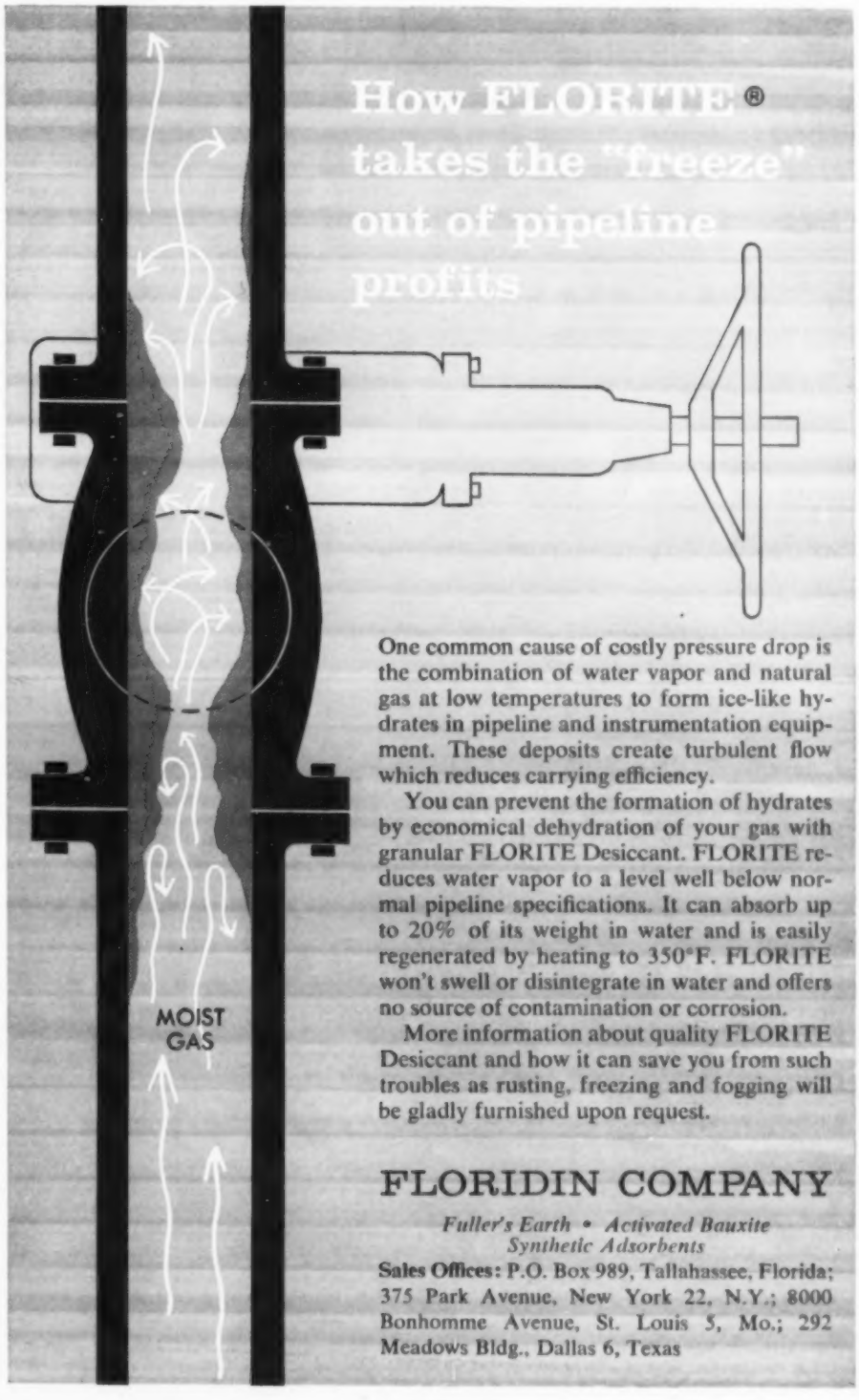
J. I. Case Company Announces Parts Division Appointments

R. F. Kehrer has been named parts marketing manager and Gordon F. Roberts was made parts control manager for J. I. Case Company. Kehrer for the past four years has been parts manager of the Industrial Division. His responsibilities will include parts catalogs, parts price lists and bulletins, sales promotion material and assistance to branch parts supervisors.

Roberts will handle inventory analysis and control of factory and branch parts and parts specifications. The new Central Parts Division will operate as a wholly seperate specialized parts organization.

Cal-Metal Pipe Corporation Furnishing Longer Pipe Joints

Cal-Metal Pipe Corporation has redesigned its plant in Baton Rouge to enable the company to provide pipe lengths up to 63½ feet. Cal-Metal produces pipe from 6⅝-inch to 42-inch range for crude, products, gas distribution and transmission lines.



One common cause of costly pressure drop is the combination of water vapor and natural gas at low temperatures to form ice-like hydrates in pipeline and instrumentation equipment. These deposits create turbulent flow which reduces carrying efficiency.

You can prevent the formation of hydrates by economical dehydration of your gas with granular FLORITE Desiccant. FLORITE reduces water vapor to a level well below normal pipeline specifications. It can absorb up to 20% of its weight in water and is easily regenerated by heating to 350°F. FLORITE won't swell or disintegrate in water and offers no source of contamination or corrosion.

More information about quality FLORITE Desiccant and how it can save you from such troubles as rusting, freezing and fogging will be gladly furnished upon request.

FLORIDIN COMPANY

Fuller's Earth • Activated Bauxite
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Sales Offices: P.O. Box 989, Tallahassee, Florida; 375 Park Avenue, New York 22, N.Y.; 8000 Bonhomme Avenue, St. Louis 5, Mo.; 292 Meadows Bldg., Dallas 6, Texas

For more data on advertised products, use Readers' Service Cards, last page.

New time multiplexing and remote se
and reduce line requirements for Du

Five new basic time multiplexing systems—and a new remote index setting feature—add to the overall versatility of *Dur-O-Pulse* . . . give you advantages available in no other telemetering system.

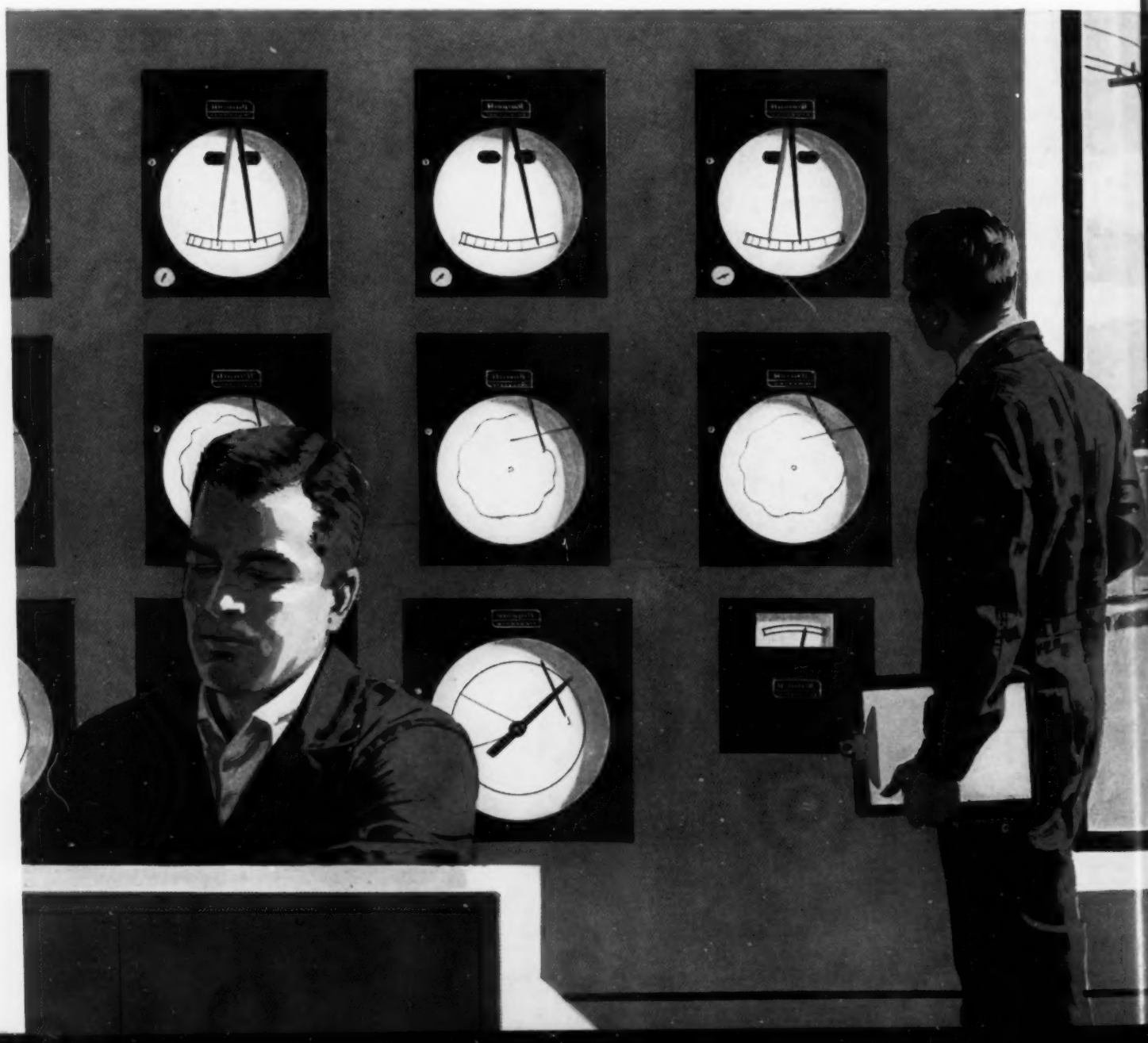
With Time Multiplexing Units—

- You can transmit up to 15 signals either in one or two directions over a single channel.
- You can add intermediate stations without adding any additional transmission lines.

With Remote Set Index—

- Easy to set—set the index, push a button and the rest is automatic: a pulse whose duration is directly proportional to the value of the set point is transmitted to remotely located controllers.
- Can be used as part of a multiplexing system.

The *Dur-O-Pulse* system measures and transmits process variables such as pressure, temperature, flow, level, voltage, current, power and speed. It can send data quickly and accurately over all types of circuits.



set index setting simplify operation for Dur-O-Pulse telemetering systems

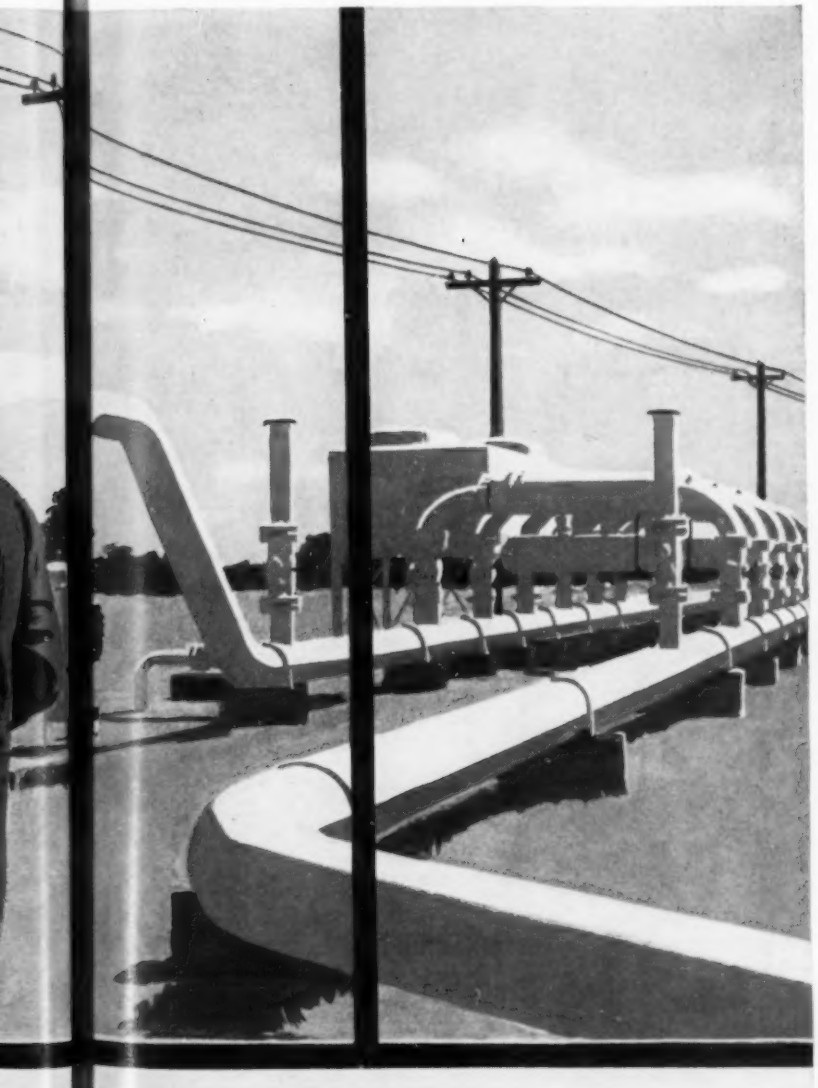
- Gives you set point indication at transmitting and receiving instruments.
- A single tone is required for the index signal when audio tone multiplexing is used.

Find out about *all* the performance and maintenance advantages of *Dur-O-Pulse* from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa. In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.

REMOTE-SET INDEX TRANSMITTER eliminates separate push buttons or switches needed to drive controller index up or down scale. To readjust controller index it is necessary only to adjust the indicating pointer to the desired set point and push the start button.

TIME MULTIPLEXING UNITS transmit up to 15 variables in one or both directions and provide a synchronizing signal to keep transmitting and receiving units in step.



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First in Control

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Everything for pipeline construction from

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EXTERNAL LINE-UP CLAMPS
HOLIDAY DETECTORS
PIPELINE LOCATORS

Why tie-up your capital in purchasing equipment, when you can rent all these items, and numerous others, for pipeline construction. And you get around-the-clock service from our experienced personnel . . . dependable operation of equipment assured by periodical checks. No delay, parts and supplies shipped same day ordered when possible.

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Tel. WA 2-9444

George E. Coty

B. J. Hancock

Grove Valve and Regulator Announces Sales Promotions

Grove Valve and Regulator Company has appointed George E. Coty, formerly vice president-sales, to vice president and general sales manager in charge of all sales activities. He will be headquartered in Oakland.

B. J. Hancock, formerly eastern regional sales manager has been named vice president-sales and will be responsible for all field sales with headquarters in Houston.

E. C. Bird becomes district sales manager in Houston and will handle sales of production valves in that region. He formerly was division manager for Gulf Coast Machine & Supply Co.

Elliott-Automation Licensed To Sell American Valve Line

Elliott-Automation Limited of London, has been licensed by General Kinetics Corporation of Englewood, N.J., to manufacture and sell the P-K Paul Valve outside the Western Hemisphere. Elliott-Automation specializes in the design, manufacture and installation of electrical, electronic, pneumatic, hydraulic and mechanical equipment for instrumentation, control and automation.

The company will introduce the venturi-ball control valve to Europe, Middle East and British Commonwealth, except Canada.

West Allis Pump Department Announces Three Promotions

Joseph J. Jacobs, has been named chief engineer; C. L. Babb, senior staff engineer, and W. W. Weltmer, senior development engineer for Allis-Chalmers Manufacturing Company West Allis Works Centrifugal Pump Department.

Jacobs had been chief engineer. He started with the company as a design engineer in 1940, and became assistant chief engineer in 1959. Babb had been chief engineer of the Centrifugal Pump Department since 1955, and has been with the firm since 1924. Weltmer came to Allis-Chalmers in 1930, and had been engineer-in-charge of research and development of the Centrifugal Pump Department.

Walter P. Hooper Named Vice President of Panellit

Walter P. Hooper has been appointed vice president and general manager of Information Systems, Panellit Division. Hooper formerly was executive vice president of Panellit, Incorporated, prior to the combining of the latter organization with Information Systems, Inc. He has been with Panellit since 1954. Previously he was with Metal Press Manufacturing Co.

Link-Belt Company Names Two New District Managers

Link-Belt Company has appointed new district managers in Dallas and Shreveport. William R. Palmer will head the Dallas office and factory branch store. He succeeds Gerald A. Stone, who will become general manager of the company's Northwestern Division with headquarters in Minneapolis. J. William Boyce succeeds Palmer as Shreveport district manager.

Palmer has been with the company since 1948 when he joined the Engineering Department. Boyce, who has been district sales engineer of the Chicago office, has been with the firm since 1949.

Roddy Sims Joins A. B. Chance Company

A. B. Chance Co., has appointed Roddy Sims as sales representative for the Petroleum Equipment Engineering and Services Division with headquarters in Houston.

Sims has been a sales representative in the oil and gas industry for the past five years. He previously spent 13 years as a design engineer for a pipe line company.

Computer Systems, Inc., Names W. A. Ogletree General Manager

W. A. Ogletree has joined Computer Systems, Inc., as general manager. He comes to Computer Systems from Burroughs Corporation where he served as manager of engineering for the Military Electronics Computer Division.

He had joined Burroughs in 1953 at the research center and held a series of technical management posts.

Harger Becomes Sales Manager For Kerotest Manufacturing Co.

Kirk P. Harger has been appointed eastern sales manager, Steel Products Division of Kerotest Manufacturing Company. Harger will be in charge of coordinating sales efforts in the eastern area with plant operations of the Pittsburgh Valve manufacturing firm. He has been with Kerotest since 1956.

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PIPELINE VENTS AND MARKERS
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PIPE GAS LINE
FLEET-LINE CO.
P. O. BOX 276-K
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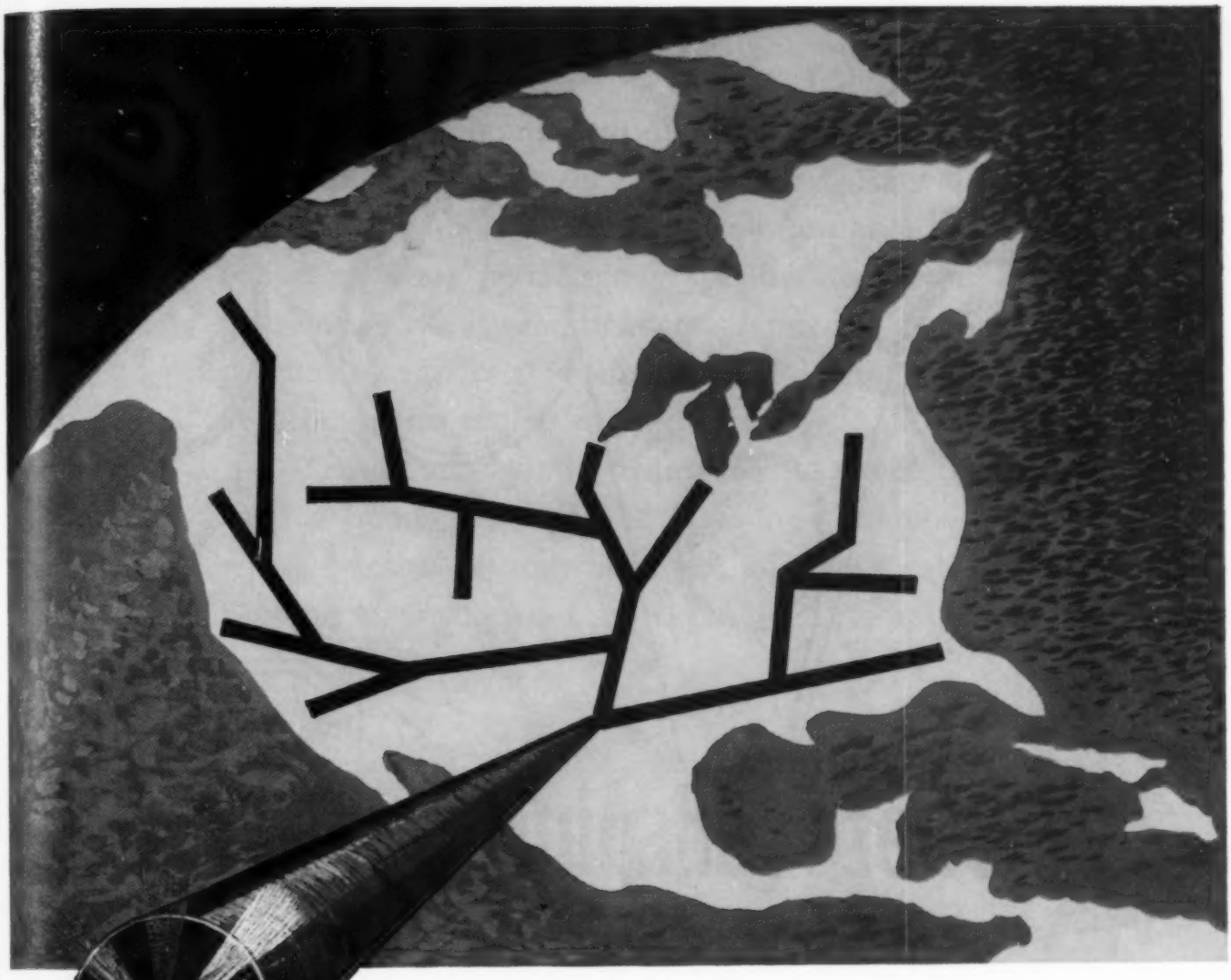
CLASSIFIED ADVERTISING

NOTICES—SERVICES

■ LINES WANTED by manufacturers agent now contacting pipe line companies, refineries, chemical plants, etc. in Texas, Louisiana, etc. Please send details to Box 8213, Houston 4, Texas.



Cook's helps "pave" and protect America's unseen highway system

Calling a pipe line a highway isn't too far off base. Not when you consider that a network of nearly 500,000 miles of pipe lines are employed to swiftly and surely deliver crude oil, natural gas and refined petroleum products to the homes and industries of America.

Cook's part in the picture is its internal and external pipe coatings that help increase through-put and lengthen the life of these vital arteries of oil and gas transmission. Which in turn means greater economy for the pipe line industry and better values in modern fuels for everybody.

Do you have a pipe coating problem? Look to Cook's for the job-prescribed coating that is designed for the specific job. And get the experienced help of our coating engineers and chemists. They'll analyze your need, provide specific product data sheets and prepare specifications for you or your contractor. Just write, wire or telephone.

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HOUSTON
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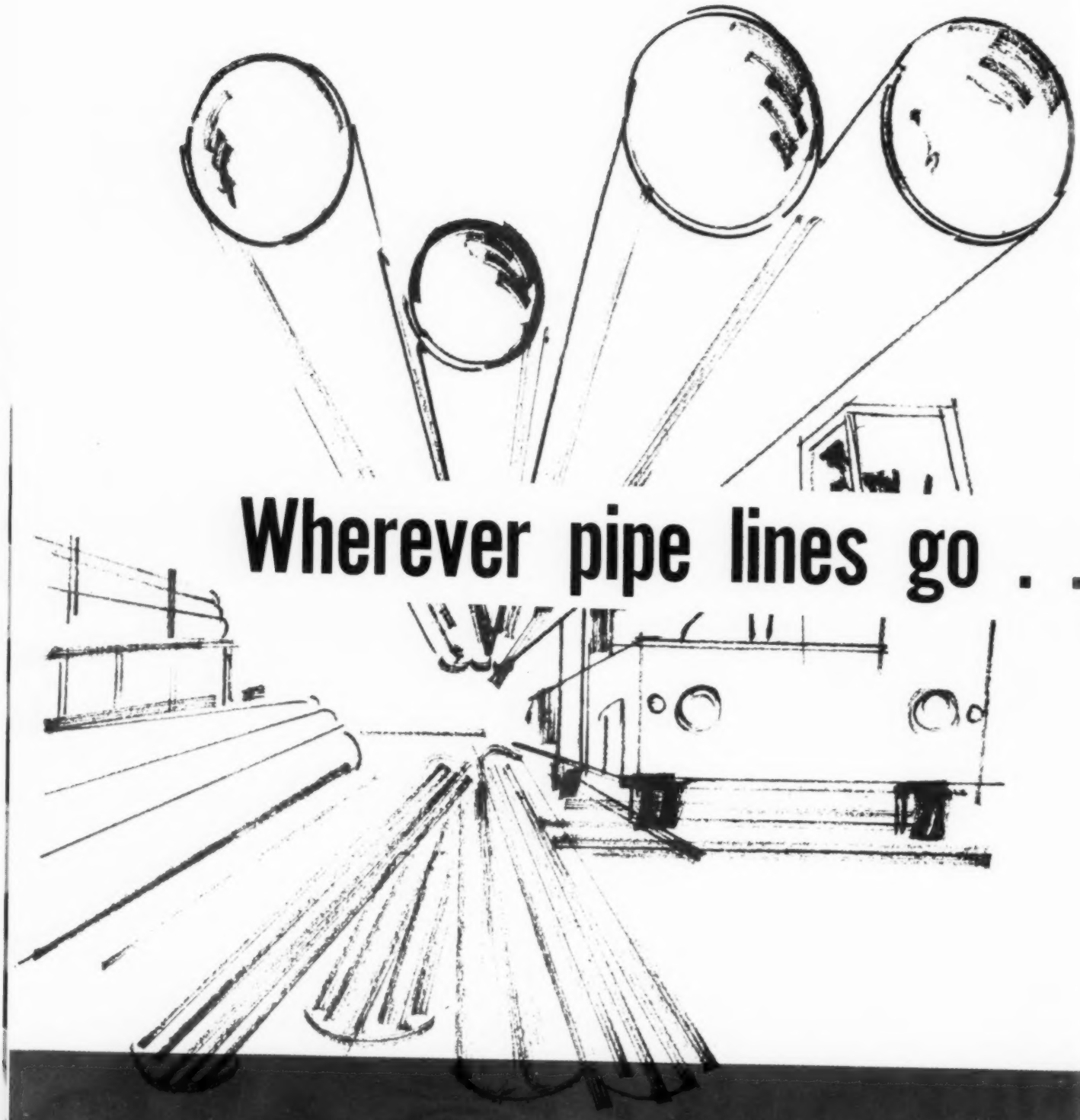
CApitol 8-2391
Teletype HO 29

For more data on advertised products, use Readers' Service Cards, last page.



Wherever pipe lines go . . .

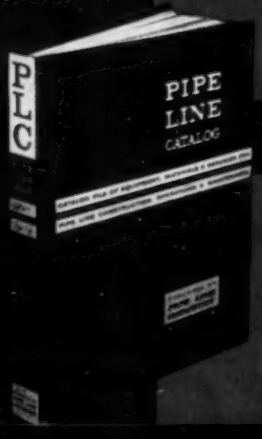
The only equipment-materials-service catalog prepared exclusively for the industry, PIPE LINE CATALOG is a library of purchasing information. Indispensable to any purchaser or specifier – operating or field executive, superintendent, foreman, engineer, purchasing agent – the catalog has data from almost 200 companies selling to the industry.

Thousands of products and services are described in this handy, one-volume, cross-indexed reference work of complete and condensed suppliers' catalogs. Finding what you want when you want it – and com-

. . . Pipe Line Catalog goes!

paring it to other products – is easy with PIPE LINE CATALOG . . . one of the biggest time and money savers in the industry.

Forget the frustrating, time-consuming chore of maintaining shelves and drawers full of suppliers' literature. PIPE LINE CATALOG makes your buying or specifying easy, convenient, efficient and economical. Use it – and save time and money.



PIPE LINE CATALOG

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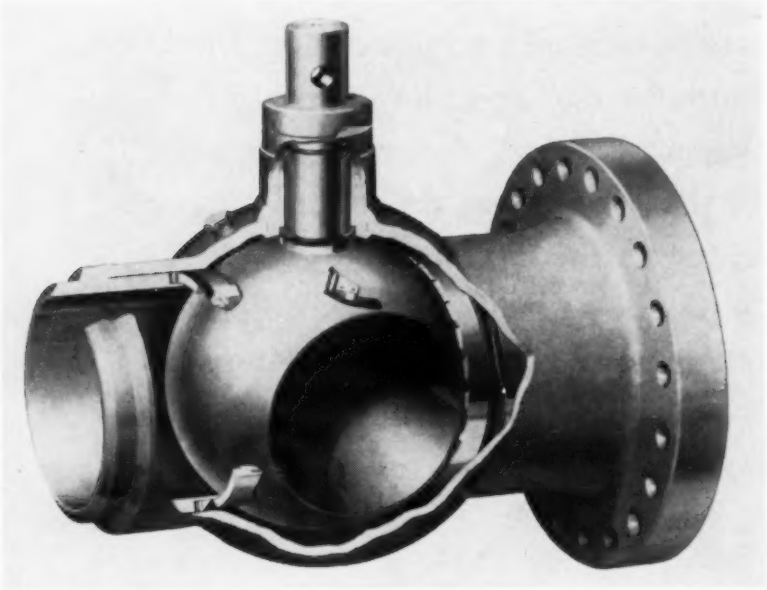
What's New in EQUIPMENT



Ball Valve

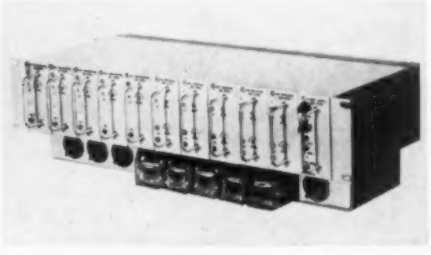
No bonnets, no gaskets and no joints are the features of Cameron Iron Works, Inc.'s, new ball valve which comes in sizes up to 36-inch diameter. Using the principle of rotating seats, the ball design requires no lubrication to seal bubble-tight and is compact in size.

Because of the long life of the rotating seats and other advances, the valve should perform at a saving even in highly abrasive and corrosive fluids. It may be installed in the most convenient position —without regard to top or bottom. All types of electric, pneumatic and hydraulic operators may be used with it. The two seat construction seals both upstream and down. Thus, the line may be blocked in both directions and the body of the valve bled off. When the valve is operated, spaces between seats and in the body cavity are flushed out. This self-flushing eliminates sticking and prevents damage that might result from freezing.

Since design is simple, special material could be used to construct the valve without extreme expenses, if it were necessary because of temperatures or extremely corrosive fluids. Each operation of the valve partially rotates the seat. This changes the relation of the mating surfaces and gains a continuous reseating, resulting in longer seat life. The valve is being made in sizes from 2-36 inches for 150 thru 600 pound ASA classes and in 2 thru 6-inch for API 1,000 psi to 5,000 psi working pressure rating.

(This item supplements Cameron Iron Works, Inc. data on Pages 64A-64-F of the Pipe Line Catalog, Third Revision.)

For more data, circle **No. E1** on Readers' Service Card, last page this issue.



AM and FS Tones

Radio Frequency Laboratories, Inc., Communications Products Division, announces its 2056 series of AM tones designed to meet low speed tone signalling and control requirements when low noise lines and inherently low noise communication circuits as provided by microwave and voice equipments are available for transmission. The 2056 series of PS tones are used when ultimate reliability and high speed keying is required. They can be used in circuits which are inherently noisy and which are subject to fading conditions.

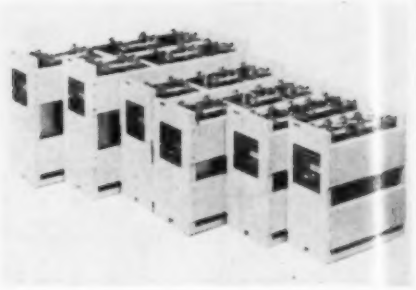
The equipment features modern design utilizing plug-in card construction and provides a unit having a maximum number of channels in a given space, plus a saving in cost. Ten AM transmitters or receivers and a common power supply are compactly mounted in a single frame measuring 3½ by 19 inches. Each channel is conveniently terminated with a terminal strip at the rear of the frame.

For more data, circle **No. E2** on Readers' Service Card, last page this issue.

Cadmium Batteries

Nickel-cadmium batteries have been added to the line of industrial storage batteries of Exide Industrial Division of The Electric Storage Battery Company.

The new batteries, having nickle and cadmium-oxide active materials contained in perforated steel pockets of the positive and negative plates, are offered by Exide for use in a number of specialized applications. Some applications include starting engines to generate emergency power, emergency lighting systems, switchgear tripping in electric utility substations, stand-by to assure continuous operation of microwave systems, emergency communications and safety equipment in marine service. They are particularly well suited for applications where power demands are extremely intermittent, and where, such as in remote locations, only minimum, infrequent maintenance and service are possible.



The new line is available in 22 electrical sizes, with eight-hour capacity ratings ranging from 10 to 450 ampere-hours, and in other special types and sizes.

For more data, circle **No. E3** on Readers' Service Card, last page this issue.

Electronic Control Link

An electronic unit which provides a display and control link between the human operator and high speed data processing or communication systems, has been announced by the Electrada Corporation. Matching the logic and speed requirements of the electronic system and human operator, the Electrada Datacom increases the flexibility of computers and communication systems.

The unit accepts digital information at line speed, automatically translates it to ordinary alpha-numeric characters and presents a clear display on the screen of a cathode-ray tube. As information is displayed, the operator may alter contents in part or in whole by striking a standard typewriter keyboard.

Both incoming and outgoing records are held in the Datacom until the operator punches the send button, causing the unit to translate the information to coded form and transmit it automatically to the associated communications network or computer. Circuit design is flexible in order to allow incorporation of the Datacon in any existing data processing or communications system.

For more data, circle **No. E4** on Readers' Service Card, last page this issue.

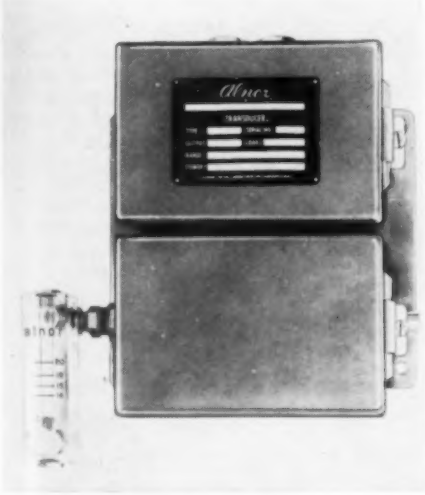
Meter Tool Kit

A complete measuring tool kit used for checking orifice metering assemblies against tolerances recommended by the AGA and ASME has been introduced by Daniel Orifice Fitting Company. Twenty-seven pieces including the "bean" orifice edge gage comes in a custom-fitted mahogany case.

With the kit it is possible to measure meter tube diameters and lengths, meter tap holes, orifice plate bores, outside diameters, flatness and edge sharpness. Instruction sheets accompany each kit. With the "bean" orifice edge gage, it cost $320, without this gage it is priced at $235.

(This item supplements Daniel Orifice Fitting Co. on pages 120-123 of the Pipe Line Catalog, Third Revision.)

For more data, circle **No. E5** on Readers' Service Card, last page this issue.



Dew Point Transducer

A new dew point transducer, Type No. 7600, has been developed to measure dew points in ranges of from —20° to 60°. The Alnor Instrument Co., No. 7600 is particularly suited for outlet measurement of endothermic gas generators used in controlled atmosphere heat treating.

A desirable continuous monitoring of the dew point is achieved by establishing a continuous flow of gas through the transducer. A millivolt output provides a choice of indicating, recording, controlling or alarm read-outs. No moving parts assures long-life system accuracy.

For more data, circle **No. E6** on Readers' Service Card, last page this issue.

KA-MO

DOES IT IN ONE OPERATION . . .

Bores Hole, Installs Casing at the Same Time . . .

Here 106' of 24" diameter casing is being installed under a railroad bed as 18 hp air-powered Ka-Mo drill bores hole ahead through compacted clay and ballast. Drilling Time: 4 hours.

Line work that crosses highway, byway and city streets calls for Ka-Mo. With a Ka-Mo drill you can install casing as you bore without fear of costly cave-ins . . . without stopping traffic or cracking pavement . . . no back filling or re-surfacing.

Your Ka-Mo drilling specialist can recommend the right drill for you. He knows his field . . . has helped many cut costs and speed line installation work. Ka-Mo drills available in 2" to 48" sizes, and larger. Powered by air, hydraulic, electric, gasoline or diesel to meet job requirements. Get in touch with your Ka-Mo man or write for Ka-Mo engineering booklet today.

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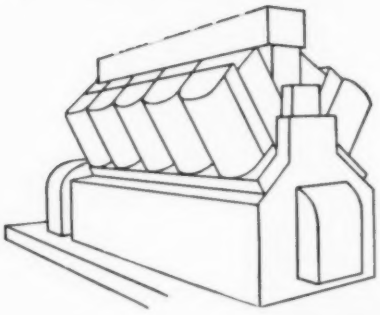
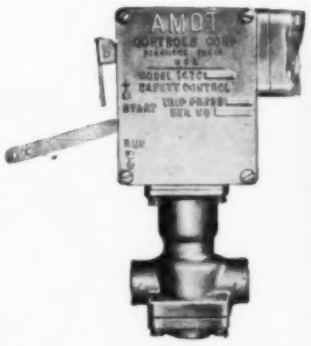
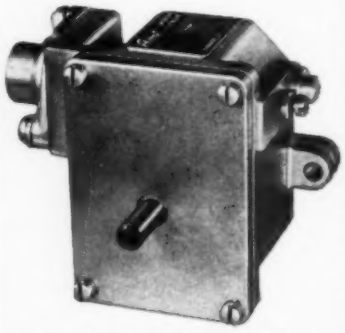




AMOT Model 1476 Controls and Accessories will form the "heart" of any Safety or Mechanical Control System. Pressure, Temperature, Vibration and Speed actuated pilot valves are available from AMOT to perform most engine and process control system functions.

Safety and Automatic Controls
Mechanical Type
Model 1476



Low Pressure Safety Control
Small Engines & Equipment
Model 2800

The AMOT Model 2800 Low Pressure Safety Control is designed for use by smaller engine and compressor owners and operators. It has the same qualities of ruggedness and reliability that have made the Model 1476 Safety Control so popular but at half the price. Model 2800 is used with a 2230 Temperature valve and 1748 Orifice to make a complete LO-PRESSURE/HI - TEMPERATURE Safety Kit.

The AMOT "tamper proof" Thermostatic Valve has become Industry's STANDARD for Engine, Compressor, and Process temperature control. Available in ½" to 1½" in cast iron or bronze; 2" to 6" in cast iron, ductile iron or bronze.

Thermostatic Valves
½" to 6" Pipe Size
Model B

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Representatives in Principal U. S. Cities

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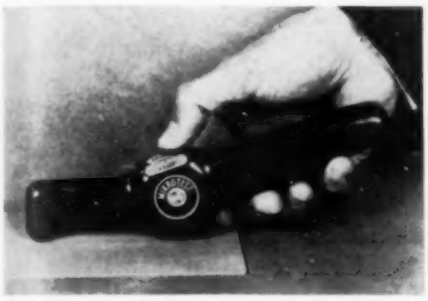
Explosion Prevention

A new explosion prevention system has been developed by Fenwal Incorporated. The protection system detects an explosion at the instant of its inception and acts within a few thousandths of a second to snuff out the blast before it can become destructive.

The system is based on the fact that there is a finite lapse in time between its ignition and the build-up of destructive pressures. The system acts within this period. It detects the beginning of the explosion, by sensing initial pressure build-up or the first tiny flash of flame and automatically reacts to snuff it out. The blast is made harmless by a combination of actions, which may include any of the following: suppression, venting, advance inerting, isolation or automatic plant or equipment shutdowns.

For more data, circle **No. E7** on Readers' Service Card, last page this issue.



Film Gages

The Mikrotest dry film thickness gages now are available in two sizes. One for lacquers, enamels, etc., has a range of 0 to 20 mils. The other model for platings, galvanizings, etc., has a range from 0 to 2 mils. Both will measure a thickness of any non-magnetic coating on a magnetic (iron, steel, etc.) base. Both are easy to use and respond with a click that can be both heard and felt when the correct measurement is made.

These gages are designed such that human differences in touch do not affect the readings. Surfaces can be measured in any position. Available from Nordson Company, Amherst, Ohio, cost is $106 for galvanizing model and $89 for lacquer model.

For more data, circle **No. E8** on Reader's Service Card, last page this issue.

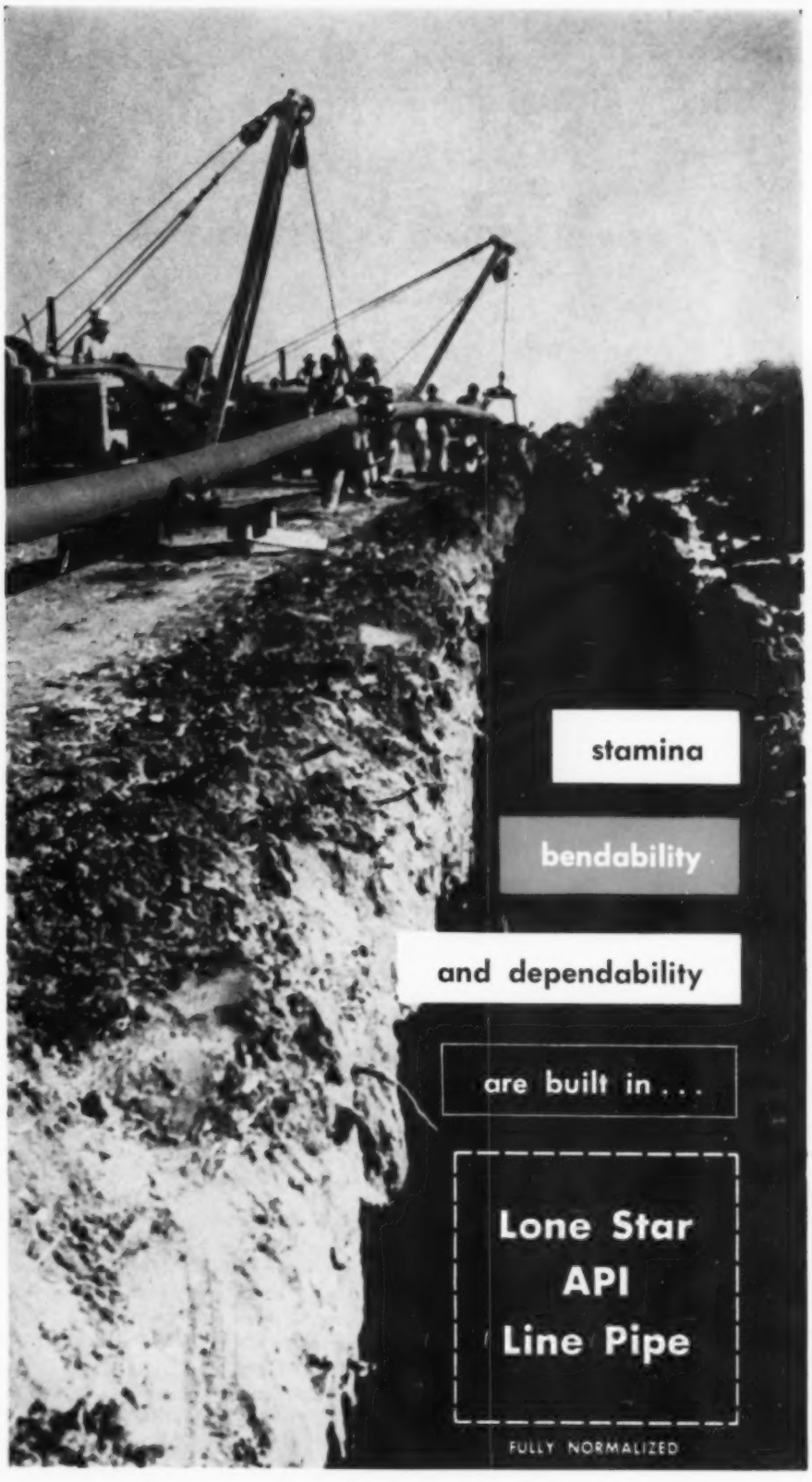
Flange Gaskets

A new high pressure series of standard ASA flange gaskets called the 6400 series Gask-O-Seal is now available from Parker Seal Company. The new series can be used with most all types of ASA flanges — raised face, flat face, lapped joint, welding neck, slip-on screwed joints, fitting flanges and other.

The new designs feature safe blow-out proof, metal-to-metal seals, plus reusability and ease of installation. The new series is recommended for temperatures from −65° F to 275° F. Special sizes and shapes are also available for higher and lower temperature usage.

(This item supplements Parker Seal Company data on page 303 of the Pipe Line Catalog, Third Revision.)

For more data, circle **No. E9** on Readers' Service Card, last page this issue.



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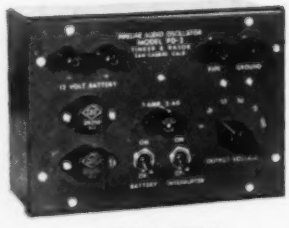
For more data on advertised products, use Readers' Service Cards, last page.

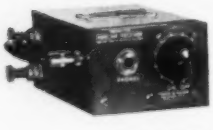
There it is!

DETECTOR

locates pipeline holidays and electrical contacts underground



OSCILLATOR



RECEIVER

Problems caused by underground pipe contacts with other lines and holidays in the protective coating can be solved by the Tinker and Rasor Pearson-type Detector which locates underground shorts in coated pipelines.

This completely transistorized unit finds trouble spots underground without the necessity of uncovering the pipe. Working in tandem, a two man crew can inspect an entire line, locating coating breaks, contacts with other lines and mapping the entire line.

The TR Underground Holiday Detector operates on a 12 volt automobile battery. It generates a 15 watt, 750 cycle, stable A.C. audio-frequency signal on a pipeline. Two 750 cycle resonate filters in the receiver reject unwanted signals.

Write today for technical data and bulletin.

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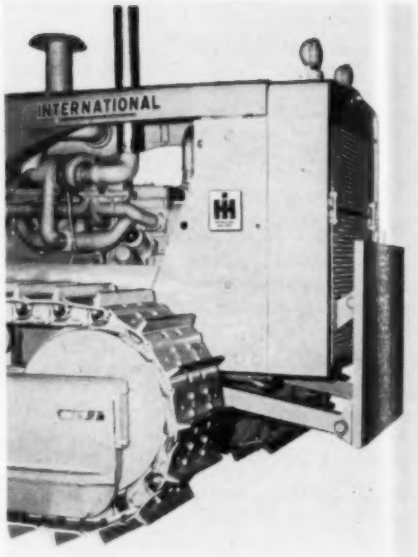

Tractor Push Plate

A direct-mounted push plate which distributes loads to four separate areas of the tractor main frame now is available for the International Harvester Company's TD-25.

The two-inch thick plate is mounted to the tractor frame by a rugged bracket-pin-strut arrangement. Top of plate is supported by two, 2-inch thick brackets, with the plate secured to two, 2¼-inch hardened steel pins. Offset and corner loadings are easily withstood, and the tractor can push with any part of the plate, whose flat surface and lipless design make it matchable with any width stinger.

For more data, circle **No. E10** on Readers' Service Card, last page this issue.

Two-Way Radio

General Electric Company announces a two-way radio designed as a space saving table model. Units up to 60 watts are available in low band (25-54 mc and 72-76 mc.) up to 50 watts in high band (144-174 mc.) and 15 watts in UHF (450-470 mc.) Depending on the frequency selected, power amplifying equipment can be obtained on an optional basis, providing 250/330 watts output.

Also on optional basis, units with selective-calling features can be made available, enabling dispatcher to give a message to a single car or group of cars.

For more data, circle **No. E11** on Readers' Service Card, last page this issue.

Why, indeed? As long as you're in a hydrogen area, there's just as much danger of explosion with one piece of equipment as there is with the other.

And the same goes for acetylene areas, too. *And* for all other pieces of electrical equipment in such an area . . . fixture hangers, seals, flexible couplings, junctions, push button stations.

Crouse-Hinds is the only single source for complete systems of UL-listed explosion-proof electrical equipment, no matter what the National Electrical Code Class or Group.

Crouse-Hinds is also your prime source for expert assistance in choosing and applying equipment for hazardous areas. A Crouse-Hinds Field Engineer is always available to help you plan complete protection in flammable atmospheres of gases, vapors or dusts.

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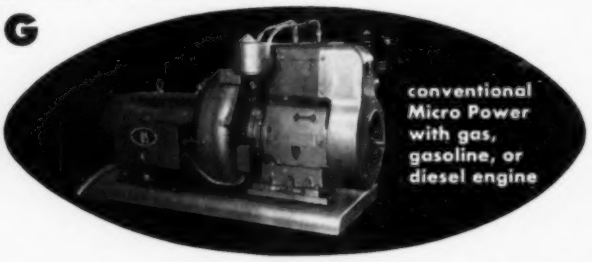

Heart of the microwave communications link between the Williams and the Seligman, Arizona, compressor station of El Paso Natural Gas Company is a United States Motors Corporation Micro Power. The engine of the conventional Micro Power in this case is replaced by a DC motor which is fed from the station batteries, from which all supervisory and telemetering equipment operates. Should the AC commercial power fail, the Micro Power continues to supply the microwave without voltage drop, droop, or break. Micro Power operates from, but isolates the microwave from the commercial power and removes the bad effects of voltage dips and peaks.

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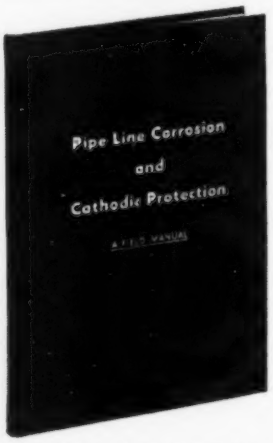

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Pipe Line Corrosion and Cathodic Protection

By MARSHALL E. PARKER

This book is designed as a practical field manual. It provides workable methods that can save you valuable time and effort in obtaining interpretive field data.

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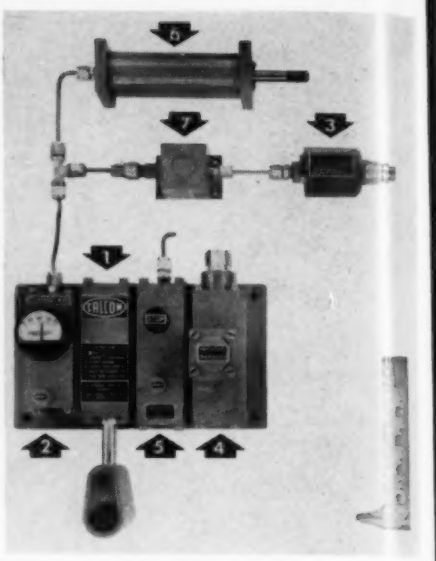
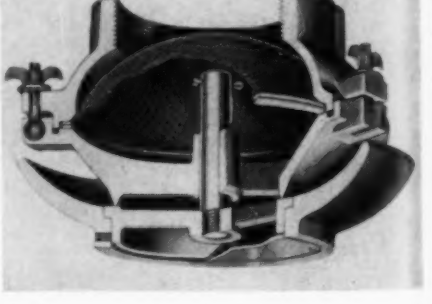


Safety Control

A self powered engine safety control system that protects all types of engine installations against dangerous overspeed, temperature and pressure conditions is available, California Controls Company, Oakland, Calif. Operated by compressed air, the system requires no batteries or other special electrical supplies necessary for the majority of the safety control systems presently available. It can put into operation almost any type of pilot operated valve, switch, warning or other device when the captive air charge is dumped to atmosphere by sensing units.

The system is designed on the modular system and standard components are combined to meet the requirements of each type of installation. All parts are connected with standard copper tubing, and all repair jobs can be made in the field by replacing standard components.

For more data, circle **No. E12** on Readers' Service Card, last page this issue.



Emergency Vent

A new 209-U Emergency vent for bulk storage tanks of petroleum products has been introduced by OPW Corporation. The vent is designed to comply with section 2133 of the National Fire Protection Association Code 30.

The new vent has a large diameter plate in the cap which is sealed with fusible metal. If fire occurs, the fusible metal melts at 200° F and the plate blows off to give full upward venting. A double fire screen gives added protection.

For more data, circle **No. E13** on Readers' Service Card, last page this issue.

Communication Carrier

A communication carrier equipment offering from one to 600 channels in a fully transistorized multiplexing system has been introduced by Lynch Communication Systems, Inc. The B910 is designed so that one channel may be purchased economically without penalty to the small user because each 4 kc channel is self-contained with its own crystal oscillator for modulation and an individual oscillator for signaling.

The solid-state carrier channel are stackable in groups of 12. Beyond the basic 12-channel group, expansion is progressive by group modulation in blocks of 60 channels to 600 channels. The basic 12-channel system is translated directly to the microwave baseband without need for immediate active pre-group equipment. This is accomplished by a new Lynch-filter design using quartz crystals in a unique ladder-type configuration.

For more data, circle **No. E14** on Readers' Service Card, last page this issue.

Check Valve

A Duo-Chek valve has been developed by Mission Manufacturing Company. The valve fits between flanges and features new concepts in sealing to withstand all pressures. Simple construction and easy installation are features of this lightweight compact valve.

A new resilient seal withstands all pressures without leaking or damage. Sealing material is molded into a groove in the plate, making an O-ring type seal. Pressure deforms the seal until metal-to-metal contact is made by the plate with the body seat, which encloses the synthetic sealing material to prevent pinching off under pressure. A teflon and metal seal also are available.

For more data, circle **No. E15** on Readers' Service Card, last page this issue.

Centrifugal Pumps

A new line of multi-stage, opposed-impeller, centrifugal pumps to handle hot or cold water, hydrocarbons, chemicals, acids, condensates and similar liquids has been announced by Pacific Pumps, Inc., a Division of Dresser Industries, Inc.

They can also be adapted for medium-pressure boiler feed service and with minor modifications, they become efficient hydraulic driving devices.

For more data, circle **No. E16** on Readers' Service Card, last page this issue.

Disc Valve

A hermetically sealed shearable disc valve, available in a range of sizes, has been announced by B. H. Hadley, Inc. The disc valve has a non-aging metallic disc that is leak-proof in the pre-sheared condition. Actuation is rapid either by pneumatic, hydraulic or pressure cartridge action. In the open position, there is full flow with minimum pressure drop. The sheared disc is completely retained and no fragments are released into the fluid stream. The valve is available in butterfly or poppet designs.

For more data, circle **No. E17** on Readers' Service Card, last page this issue.

How to detect moisture down to one part per million

CEC makes it easy, with the most complete line of moisture monitoring equipment on the market.

If you are faced with problems in product or system contamination by water, look into the capabilities of these rugged, reliable instruments:

26-301 and 26-302 Portable Moisture Monitors **– For lab and field use, the 26-301 measures water content of gas from 1-1000 ppm; the 26-302 measures from 1-20,000 ppm. Both units operate on 110V line power or accessory battery pack.** ***Bulletin CEC 1834-X8.***

26-350 High-Pressure Moisture Monitor **– Designed initially for missile checkout, this instrument also tests water concentrations in high-pressure gas for many commercial applications. Maximum operating pressure is 6000 psig.** ***Bulletin CEC 1855-X9.***

26-310 Process Moisture Monitor **for plant monitoring of gaseous process streams. The explosion-proof analyzer mounts directly on-stream. Remote control and continuous readout are provided in the control room.** ***Bulletin CEC 1845-X31.***

CEC's 26-312 Liquid Process Moisture Monitor – The only instrument in existence for continuous and accurate measurement of water content in liquid-process streams. **Bulletin CEC 26312-X2.**

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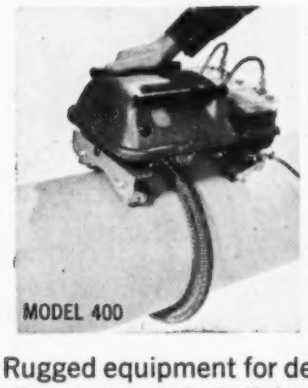

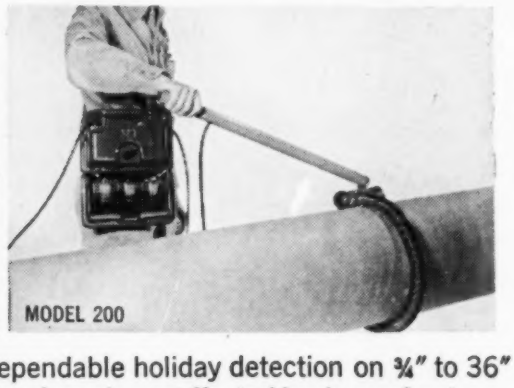

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Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers' Index. Simply circle code numbers of items desired—sign and mail card.

Plug Valves

Four bulletins covering many aspects of the lubricated plug valves is offered in a literature kit from Walworth Company. Bulletin titles are Service Fleet, Rolotork, High Strength Cast Iron and Lubricating Manual. They are all illustrated.

A four page section of the lubricating manual deals with the selection of the proper lubricant to suit the service of the valve. Over 600 applications are listed.

To get a copy, circle **No. E18** on Readers' Service Card, last page this issue.

Wire Mesh Filter

Complete data sheets, describing over 225 items of 20 basic types of standard woven wire mesh element-in-line filters are available from Aircraft Porous Media, Inc., subsidiary of Pall Corporation. In addition to the list of standard units, the literature describes options which make possible hundreds of additional items.

Each of the data sheets shows a cross-sectional view of the filter element and housing. Working pressure, temperature ranges, port sizes and other significant factors are listed for each type shown. The tabular information includes part number, port type and size, rated flow, pressure drop and particle removal ratings.

To get a copy, circle **No. E19** on Readers' Service Card, last page this issue.

Water Resources

A 16-page booklet has been released by Caterpillar Tractor Co. on water resources which covers the story of water and huge money outlay necessary to pay our annual water bill each year.

The booklet discusses the problem of growth in population and industry relating to the water problem and tells ways in which Americans are working to solve it with better farming practices and watershed control programs.

To get a copy, circle **No. E20** on Readers' Service Card, last page this issue.

Butterfly Valves

A brochure on butterfly valves has been issued by Mason-Neilan describing flexibility available in valves for control of large volumes of liquids or gases.

The folder pictures typical variations of light and heavy duty wafer style valves and describes the three basic body designs swing-through angle seating or soft seat. The illustrated four-page folder shows a variety of valve actuators and special arrangements.

To get a copy, circle **No. E21** on Readers' Service Card, last page this issue.

Dual-Fuel Engines

A new 24-page data book is available from English Electric giving detailed information, specifications and operational data on the new line of diesel and dual-fuel engines both standard and turbocharged in sizes from 148 to 2,104 bhp.

To get a copy, circle **No. E22** on Readers' Service Card, last page this issue.

Pipe Fitters Manual

Information needed for pipe fitters and pipe welders is found in this Pipe Fitters Manual, published by Tube Turns Division of Chemetron Corporation. The comprehensive 72-page handbook is a pocket book size and includes tables, illustrations, and text which give important mathematical, physical, chemical and metallurgical data and related design, layout and mechanical information at a glance.

Subjects include characteristics of welded and threaded piping; basic mathematical formulas and conversion factors; dimensions of welded fittings and flanges and commercial pipe sizes; electrode data and practical tips on welding and properties of pipe, metals and fluids.

To get a copy, circle **No. E23** on Readers' Service Card, last page this issue.

Speed Reducers

A bulletin which describes a completely redesigned and expanded line of "balanced design" parallel shaft reducers in 57 sizes, including 23 new sizes has been released by Link-Belt Company.

The 36-page booklet includes full information for selecting the correct drive for every application. Sixteen pages of rating tables contain thermal and mechanical horsepower ratings for each input and output speed. Load classes are shown for almost 250 driven machines.

To get a copy, circle **No. E24** on Readers' Service Card, last page this issue.

Tape Manual

Prepared for the pipe line contractor, Seamless Rubber Company has published a field manual on its Safe-T-Clad polyethylene tape.

The manual brings to the attention of the contractor all phases of construction techniques and costs of the tape method.

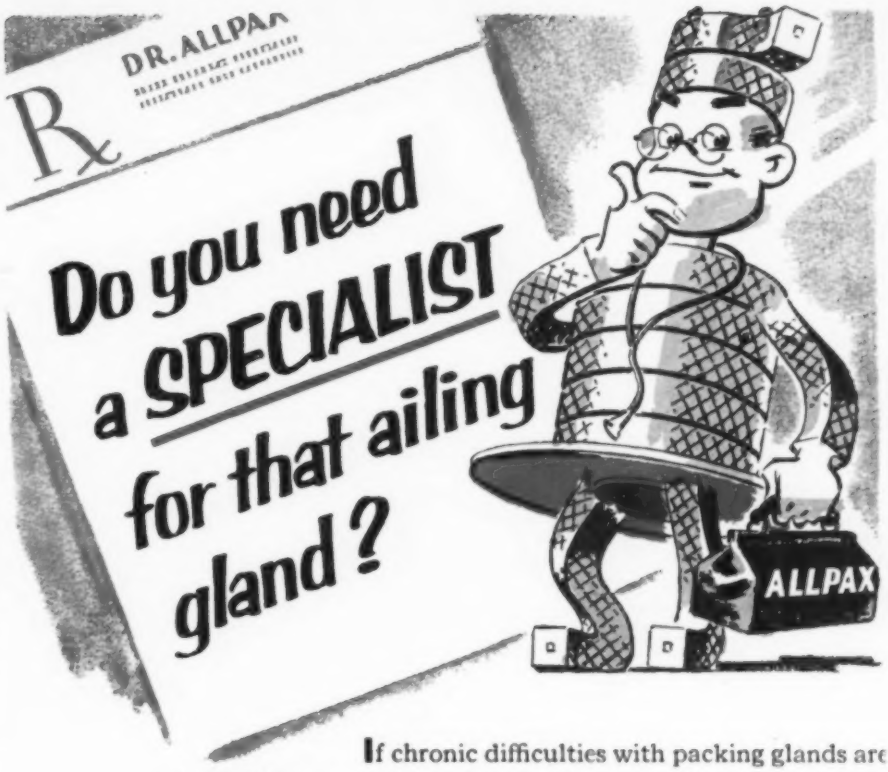
To get a copy, circle **No. E25** on Readers' Service Card, last page this issue.

Alarm/Control System

General Electric Communication Products Department has issued a bulletin on a high capacity alarm/control system providing an inexpensive method of locating faults at unattended remote operations and controlling "on-off" functions remotely.

A basic system consists of a master interrogator unit and from one to ten remote responders. A pulsed tone is transmitted through the network and returned, giving positive indication of alarm or control functions.

To get a copy, circle **No. E26** on Readers' Service Card, last page this issue.



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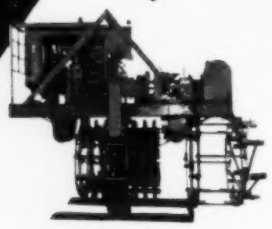
MYOCO

CLEANING and PRIMING MACHINES

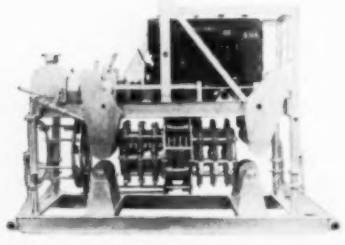


MYOCO MODEL "DR"

Especially designed MYOCO Counter Rotating Heads on this cleaning and priming machine give double cleaning action to pipe.

Seam welds are cleaned thoroughly on both sides.

This fast, dependable unit is powered by an International U-9 self-starting engine using the Ramsey transmission. Engine exhaust is utilized to heat primer tank. Sizes: 3" through 36".



MYOCO CLEANING AND PRIMING MACHINE

Set on a stationary base for yard cleaning this 6-12 Model will clean and prime pipe 3" through 14" diameter plain end.

These machines, like all the equipment at Myoco, can be rented to save you capital, investment and storage costs. Trained, courteous personnel are available 24 hours a day with fast transportation to serve you. Efficient equipment operation is assured by periodical checks. All parts and supplies are shipped the same day, when possible.

Write for our catalog

MORRIS-YOUNG-OWENS CO. PIPELINE EQUIPMENT AND SUPPLIES MYOCO

MORRIS-YOUNG-OWENS CO.

PIPELINE EQUIPMENT AND SUPPLIES

P. O. Box 35137 • Houston 35, Texas

PArkview 3-0110

In Canada: MYOCO LIMITED, Rural Route 1, Midland Ave. N., Agincourt, Ontario, Canada Tel. WA 2-9444

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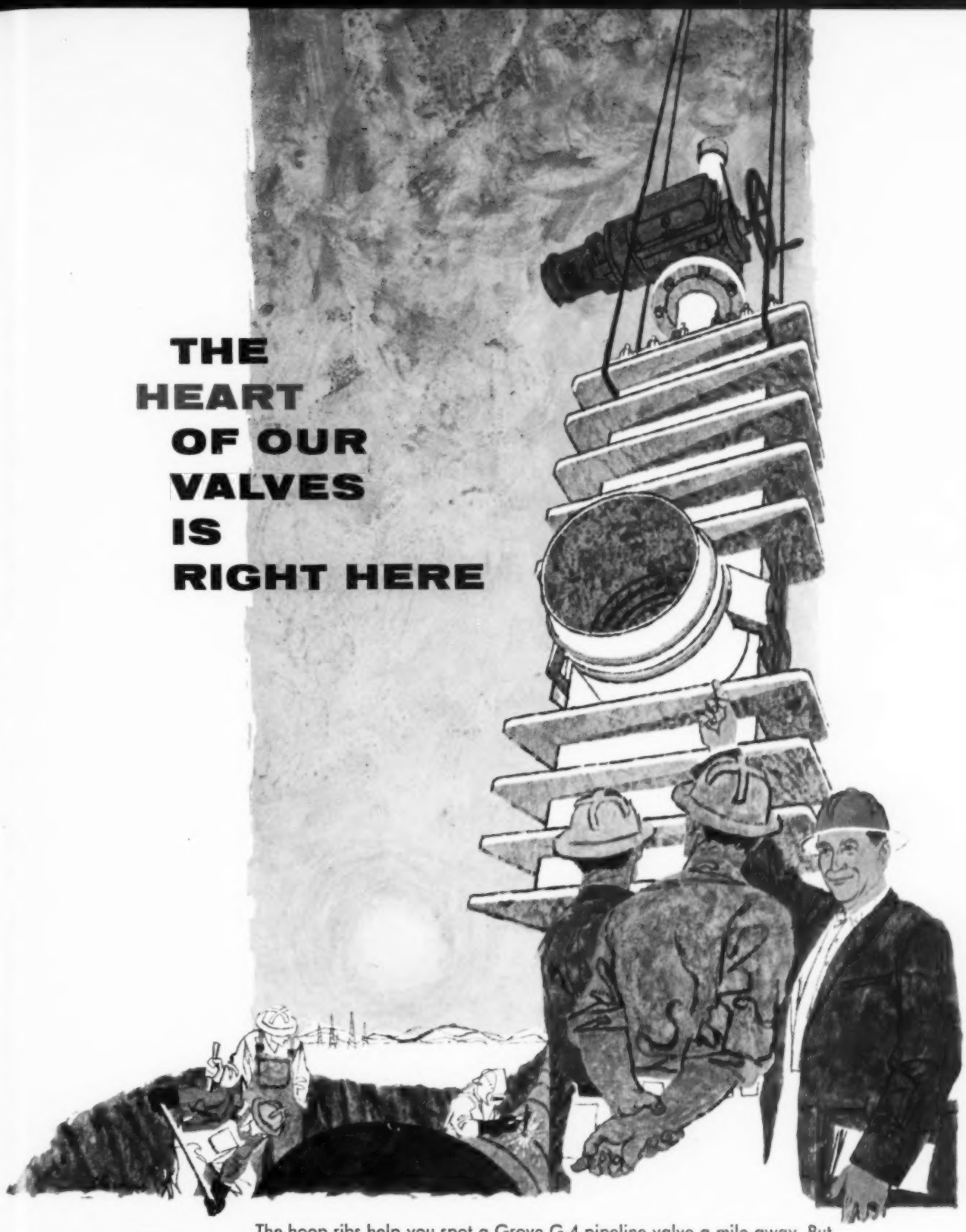
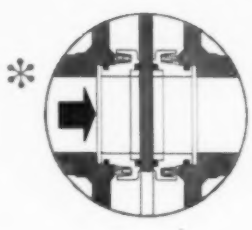


THE HEART OF OUR VALVES IS RIGHT HERE



The hoop ribs help you spot a Grove G-4 pipeline valve a mile away. But the heart of this valve is its exclusive *protected Seal-"O"-Ring* ® system. We have designed outer and inner metal seat rings that shield the o-rings on each side of the gate from damage by bore contaminates. The inner seat rings also function as a primary metal-to-metal seal backed up by the o-rings. And to assure fast, easy open and close, the inner metal rings scrape foreign matter off the gate while the o-rings squeegee it clean. Protected o-rings, metal-to-metal seal, self cleaning—plus no lubrication ever, have made Grove a leader in pipeline valves.

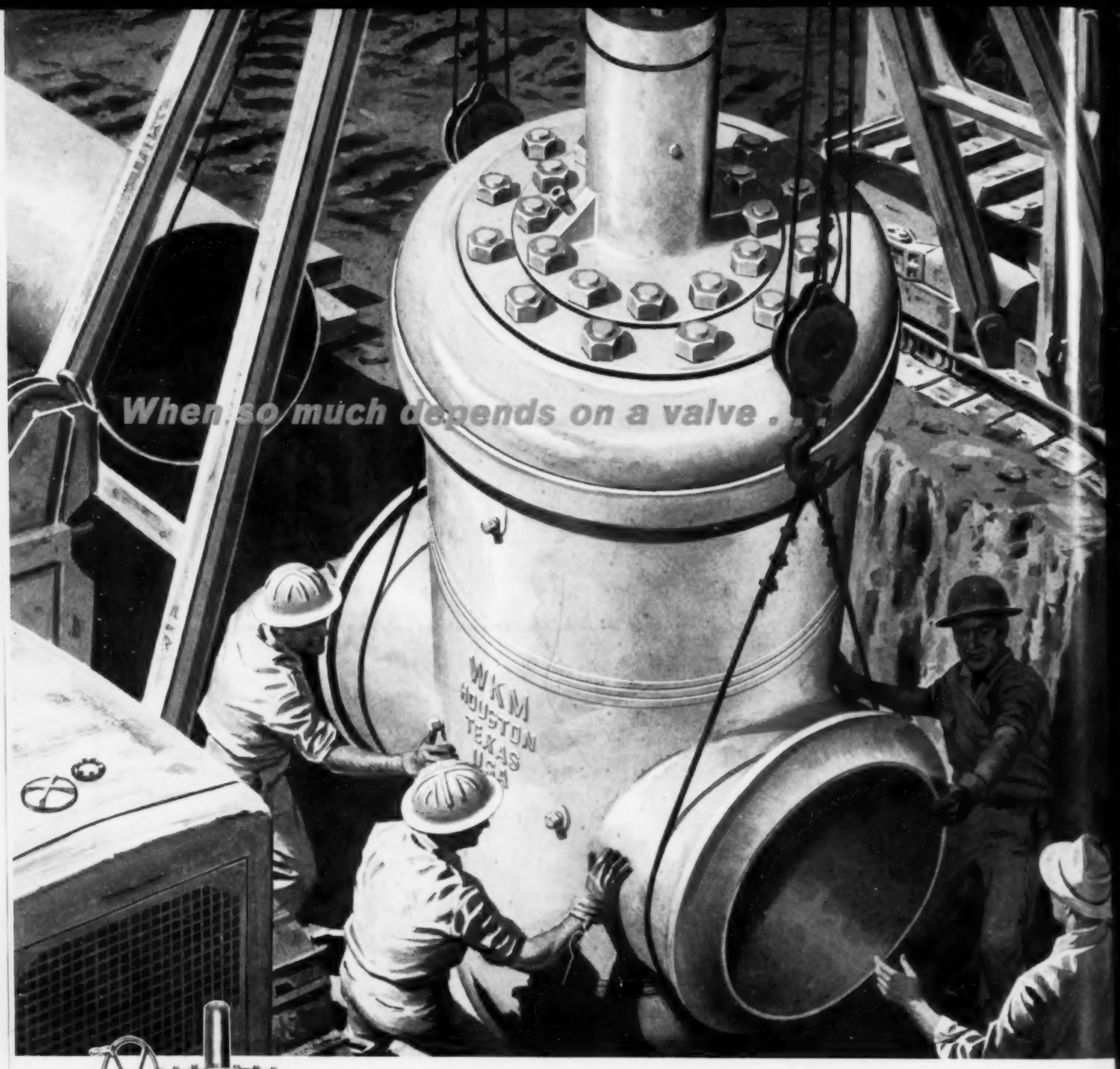
GROVE PIPELINE VALVES

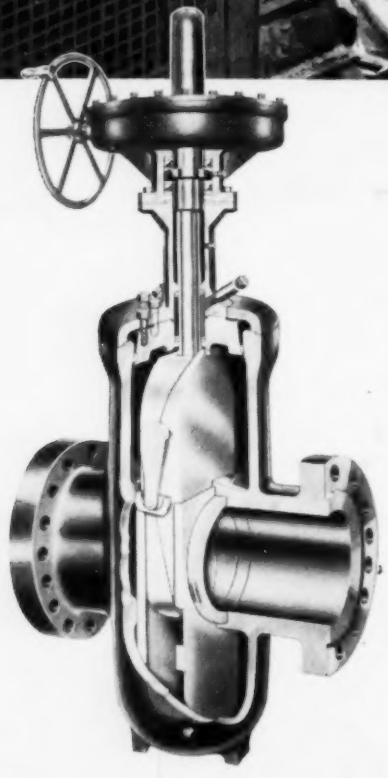
GROVE VALVE AND REGULATOR COMPANY

A Subsidiary of Walworth

6529 HOLLIS STREET • OAKLAND 8, CALIFORNIA

Offices throughout the U. S. and in Western Canada





W-K-M Expanding Gate Valves seal positively with *controlled force*

You exert unique control over the seating in W-K-M Expanding Gate Valves. Fully opening or closing the gate causes it to *expand*. So you can make as tight a seal as you want . . . first Teflon-to-metal, then metal-to-metal.

This extra degree of control insures maximum dependability over long periods of use or disuse . . . under a wide range of temperatures and pressures . . . with all pipeline ladings.

The exclusive W-K-M Expanding Gate is a big reason why W-K-M pipeline valves outnumber any other valve in mainline service. Specify them.

Exclusive expanding gate is full-bore, seals positively upstream and down.

Sizes: 2" through 12" at leading supply stores; sizes through 36" on special order.

Pressures: ASA 300 through ASA 1500 lb.

W-K-M

DIVISION OF ACF INDUSTRIES INCORPORATED

P. O. BOX 2117, HOUSTON, TEXAS

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